THURSDAY, AUGUST 20, 1885

PROFESSOR STOKES ON LIGHT

Burnett Lectures, Second Course. On Light as a Means of Investigation. By G. G. Stokes. (London: Macmillan and Co., 1885.)

THE interest raised by the first series of these lectures is fully sustained by this second instalment, though the subject-matter is of a very different order. *Then*, the main question was the nature of light itself; *now*, we are led to deal chiefly with the uses of light as an instrument for indirect exploration. It is one of the most amazing results of modern science that the nature of mechanisms, too minute or too distant to be studied directly with the help of the microscope or the telescope, can be thus, in part at least, revealed to reason. This depends on the fact that a ray of light, like a human being, bears about with it indications alike of its origin and of its history; and can be made to tell whence it sprang and through what vicissitudes it has passed.

The lecturer begins by pointing out that this indirect use of light already forms an extensive subject; and he then specially selects for discussion half-a-dozen important branches of it. Many readers will, we fear, be disappointed when they find that *Dispersion* (whether ordinary or anomalous) is not included in this list. It is tantalising to feel that we are not (for the present at least) to have the opinion of the author on the classical researches of Cauchy, or on the more recent speculations of Sellmeier, Helmholtz, and W. Thomson. It would, however, be unjustifiable to construe this omission into an indirect assertion that we do not yet know for certain *what* Dispersion tells us:—though the parts of his wide subject which Prof. Stokes has selected for discussion are, each and all, such as give indications of a definitely interpretable character.

The first of these is Absorption. Here we have the explanation of the colours of bodies; the testing ray having gone in, and come out "shorn." This leads to the application of the prism in the immediate discrimination of various solutions which, to the unaided eye, appear to have the same colour. It is shown how, by a mere glance, the chemist may often be saved from fruitless toil, occasionally from grave error.

From the study of what rays are absorbed, the transition is an easy and natural one to the study of *what becomes of them* when they are absorbed. Here we have heating, chemical changes, phosphorescence, &c. The remainder of the lecture is devoted to an exceedingly interesting treatment of the beautiful subject of fluorescence.

The second lecture begins with Rotation of the Plane of Polarisation of light by various liquids, with its important application to saccharimetry. Then we have Faraday's discovery of the corresponding phenomenon produced in the magnetic field, with its application in the discrimination of various classes of isomeric compounds. But the author, true to his system of mentioning practical applications only, omits all reference to quartz under the first of these heads and to gases under the second. And he does not even allude to the interesting questions recently raised as to the form of the general wave-surface in these curious circumstances.

Then comes the "still vexed" question of the history of Spectrum Analysis. The present view of it must, of course, be carefully read:—it is much too long to be here extracted in full, and to condense would be to mutilate it. Of course the claims of the author himself are the only ones to which scant justice is done. But the President of the *British Association* of 1871 fortunately gave, in his opening address, the means of filling this *lacuna*. Just as the Gravitation-theory of an early Lucasian Professor was publicly taught in Edinburgh University before it became familiar among scientific men, so the present Lucasian Professor's suggestions for the analysis of the solar atmosphere, by means of the dark lines in the spectrum, were publicly explained in the University of Glasgow for *eight successive years* before the subject became generally known through the prompt and widespread publicity given to the papers of Bunsen and Kirchhoff! The following are Sir William Thomson's words of 1871:—"It is much to be regretted that this great generalisation was not published to the world twenty years ago . . . because we might now be [*sic*] in possession of the inconceivable riches of astronomical results which we expect from the next ten years' investigation by spectrum analysis, had Stokes given his theory to the world when it first occurred to him."

The third lecture is devoted to the information which spectrum analysis affords as to the chemical composition of the sun's atmosphere, and its physical condition; the classification of stars, the constitution of nebulæ, and the nature of comets. Those who still maintain that the temperature of the sun's body is comparatively moderate are very summarily dealt with. Then follows a passage describing, in homely language fitted to be understanded of all, the state of the sun's atmosphere. This is specially noteworthy, as showing how efficiently a Master can impress on his readers the most vivid ideas without requiring to use any but the simplest of language.

The remarks on the nebulæ and on comets will be read with great avidity; and, by the majority of readers, with some surprise. For it is stated that the planetary nebulæ, "making abstraction of the stellar points, consist of glowing gas." And of comets we find:—"There can no longer be any doubt that the nucleus consists, in its inner portions at least, of vapour of some kind, and we must add incandescent vapour . . ." An ingenious suggestion as to the source of this incandescence is introduced as the "green-house theory." The nucleus is supposed to be surrounded by an envelope of some kind, transparent to the higher but opaque to the lower forms of radiation. Thus solar heat can get freely at the nucleus, but cannot escape until it has raised the nucleus (in part at least) to incandescence. The coma and tail are formed by the condensation of small quantities of this vapour, so that they are mere mists of excessive tenuity. Herschel's suggestion, that the development of the tail is due to electric repulsion exerted by a charge on the sun, is spoken of with approval; and the production of the requisite charge of the mist-particles is regarded as a concomitant of condensation. Nothing, however, is said as to the opposite charge which the comet itself must receive, nor of the peculiar effects which would arise from this cause:—whether in the form of a modification of the shape of the comet's head, or of a modification of its orbit and period

due to a constantly increasing attraction exerted by the sun upon a constantly diminishing mass.

Of course, if this novel theory can stand the test of a full comparison with facts, it will have established its claim to become part of science. But it is hard to take leave of the simple old ideal comet:—the swarm of cosmical brickbats:—something imposing because formidable; and to see it replaced by what is, in comparison, a mere phantom, owing its singular appearance to the complexity of the physical properties it possesses and the recondite transformations perpetually taking place in its interior. The old idea of a comet's constitution was not only formidable, but was capable of explaining so much, and of effecting this by means so simple and so natural, that one almost felt it deserved to be well-founded! The new idea makes it resemble the huge but barely palpable 'Efreet of the *Arabian Nights*, who could condense himself so as to enter the bottle of brass with the seal of Suleymán the son of Dáood!

It is much to be desired that more detail had been bestowed on the nebulæ. As nothing is said about the origin of their incandescence, we must take for granted that it is supposed to be due to gravitation. A few rough numerical assumptions as to dimensions, total mass, &c., and the consequent thermal condition at each stage of condensation, would have formed materials for a most instructive explanatory note.

The last lecture deals with solar protuberances; the (so-called) Döppler's principle, and the results of its application; and, finally, with the body of the sun. The explanation given of the peculiar and rapidly changing structure of the sun's apparent disc, which is so well shown in Janssen's splendid photographs, reminds us of a suggestion made several years ago:—viz. that a succession of instantaneous photographs should be taken, at short intervals, of so homely an object as a basin of very hot "beef-tea," which has been agitated so as to bring the flocculent matter fully into suspension, and is then left to itself as nearly as possible free from rotation.

The passages in the present volume which, taken by themselves, would indicate the ulterior object of the lectures are not numerous, and nowhere bear the appearance of having been inserted for a purpose, so naturally do they arise as comments on what has just been discussed.

We wish the Author as high a measure of success in his final effort, the most arduous of the three, as he has already attained in the others:—it would be preposterous to wish him a higher. The series will then form an exceedingly valuable contribution to a class of literature in which marked success is scarcely attained once per generation, and is justly valued in proportion to its rarity.

P. G. TAIT

AGRICULTURAL EXPERIMENTS

Review of Agricultural Experiments by the Right Hon. Sir Thomas Dyke Acland. (London: Clowes and Co., 1885.)

THIS purports to be a critical review with suggestions, and is actually an attack upon the objects, aims, and results of the Sussex Association for the Improvement of Agriculture. The writer brings a long experience and a good business faculty to bear upon the working of a scientific organisation, and with some success so far as these instruments may be used as tests of the value of a delicate task requiring very special knowledge. The attitude of mind of the reviewer of these experimental results is one of scepticism. This he does not scruple to express in such terms as "we all felt rather sceptical," and "we suspected," and "I have made in all four visits to Sussex to endeavour to get at the truth." Again, "Well, thought I, this must be a queer kind of farming, perhaps I shall enlarge my experience. I think I have made out since that the local experience, however practical, may be the better of a little expansion." With such introductory remarks we can hardly look for the cold judicial criticism that commands attention and carries conviction.

The inquiries of the Sussex Association have been directed to very practical questions, viz.:—

What do roots (turnips, mangolds, &c.) require?

What do wheat and other cereals require?

What does grass or pasture require?

These objects Sir Thomas Acland appears to view in two opposite and irreconcilable ways. First, he seems to doubt the possibility of these questions being solved by experimental processes. Secondly, he appears to consider that they have all been answered long since. He thus discounts the value of the Sussex results from two points of view, each of which is destructive of the other. It is true that the leading facts constituting the answers to the above important questions have now been firmly established for many years, and that these answers were known almost a generation ago to such leading men as the late Philip Pusey, and all more recent scientific agriculturists. The value of such stations as that known as the Sussex Association consists in its power of impressing and verifying such facts, as well as in discovering new ones, and we think, under Mr. Jamieson's able guidance both of these objects are being accomplished. Among new ideas promulgated by the Sussex Association is that which is paragraphed by Sir Thomas Acland under the heading, "Battle of the Phosphates." Mr. Jamieson's contributions upon this important subject are passed over with something akin to contempt, and yet (however distasteful his conclusions may be to manufacturers of "superphosphates") his results remain unrefuted, and the most recent experiments at Woburn point, on the whole, to similar conclusions. The establishment of the value of "insoluble" phosphatic minerals reduced to a fine state of division is due in a great measure to Mr. Jamieson, and he has incurred no little unfriendly criticism on account of this new doctrine, which touches the pockets of certain strong interests. This is altogether the leading truth brought out and fought for by Mr. Jamieson, and yet it is dismissed by Sir Thomas Dyke Acland in a manner which appears to the present writer as simple superciliousness.

One could scarcely expect to read sixty-four pages of printed matter from the pen of Sir Thomas Dyke Acland without finding grain as well as "chaff." We therefore wish to set forth the useful criticisms which the Sussex Association would do well to notice. First, then, there is the fallacious method adopted in endeavouring to translate field results into money values. Not content with leaving the number of bushels per plot and pounds of straw increase to the judgment of the reader, an effort has been

made to put a value upon these increased quantities. In valuing wheat at 5*s.* per bushel and straw at 2*l.* per ton the compilers of the report made a great mistake, of which their critic has not been slow to avail himself. Here he "shells" them unmercifully and effectually, especially as the straw at 2*l.* per ton turns out to be the chief item for turning loss into profit.

This is, however, entirely an artificial value, the result of restricted supply, and Sir Thomas is perfectly justified in dismissing the item entirely by compounding it with the cost of the farmyard manure, letting straw and manure mutually discharge each other's claims.

Another point successfully urged is the smallness of the plots. What possible reliance can be placed upon plots 112th of an acre in which pounds per plot are at once alleged to represent hundredweights per acre. The multiplication of unavoidable errors, and the exaggerations of extremely local differences in the soil itself, are simply fearful to think of. The larger the area the better. If acre-plots could be used so much the better, and 10-acre plots would be better still—the only limit in size being, to our mind, convenience. But 112th parts of acres must induce a feeling of distrust in the breasts of those who are practically acquainted with land. The sources of error may be enumerated as follows:—imperfect distribution, unavoidable waste in distribution, minute differences in the soil, irregular germination of the seed, partial insect attacks, direct accidental injuries or the reverse (as, for example, an animal trespassing upon a plot, or a horse dropping his dung upon it), errors in weighing, errors in severance from the ground, and other unavoidable difficulties which belong to the carrying out of field experiments,—all of these errors are magnified in the case of small plots, and minimised by the use of large ones. In these directions the criticisms made by Sir Thomas Acland are valuable: but we should like to have seen a greater sympathy with an honest effort, and less anxiety to hold up any results of value as stale, antiquated, and unnecessary.

Any one who has lived as long as Sir Thomas Dyke Acland must know that the proclamation of things old as things new is not confined to agricultural chemists, and he should be more ready to accept as inevitable the *dictum* of the wise man, that "the thing that hath been, it is that which shall be; and that which is done is that which shall be done."

THE NEW EDITION OF "YARRELL'S BRITISH BIRDS"

A History of British Birds. By the late William Yarrell, V.P.L.S., F.Z.S. Fourth Edition, Revised to the End of the Second Volume by Alfred Newton, M.A., F.R.S., continued by Howard Saunders, F.L.S., F.Z.S. Parts xx.-xxx. (London: Van Voorst.)

THE students of British birds have at last received the two final numbers of the new edition of Yarrell's celebrated work on their favourite subject, which was commenced as long ago as 1871. Fourteen years, it must be acknowledged, is a long time to wait, but on the other hand the subscribers to the new "Yarrell" have in compensation of the delay not what would be called in ordinary parlance a new edition, but what is, in fact, a complete and exhaustive summary of the present state of our knowledge of this subject, prepared by two of the greatest living authorities on British ornithology.

The two first volumes of the fourth edition of "Yarrell's British Birds," which were brought to a conclusion by Prof. Newton in 1882, were devoted to the birds of prey, the passerine birds, and the picarians. In June of that year Mr. Saunders undertook to finish the work, "not willingly nor with a light heart," but, as he tells us, "after considerable pressure and at much personal sacrifice." Forewarned by what had previously occurred, Mr. Van Voorst insisted that time must be part of the "essence of the contract," and stipulated with the new editor for the completion of the third and fourth volumes by June 1885, which, after allowing for six months' leave of absence, gave Mr. Saunders only two years and a half to prepare his account of nearly two hundred species. It cannot be denied that this was somewhat severe upon the new editor, and that, considering the pressure brought to bear upon him, the mode in which he has completed his task within the time assigned to him, deserves our highest compliments.

As has been already pointed out the so-called new "Yarrell" is, in fact, a new work. The vast amount of knowledge of British birds and their distribution acquired during the forty-two years which have elapsed since Yarrell's original work first appeared, rendered it absolutely necessary that such should be the case. It would have been much better, in our opinion, to have discarded the name of Yarrell altogether, and to have employed the leading ornithologist of the period to write a new work on British birds. But as Mr. Van Voorst, doubtless for sufficient reasons, preferred to retain the time-honoured name of Yarrell on the title-page, the new "editors" as they call themselves have, we think, surmounted the difficulties of their position with singular success. Where practicable, we are told, the original phraseology has been followed with due modifications, the opening words of the sentences have been preserved, and extracts from the authors and correspondents quoted by Yarrell have been retained. "This work of selection and adaptation has," we can well believe, "entailed severe labour." It is obvious, in fact, that it would have been a much simpler task to write most of the articles new from the beginning than to adapt those prepared by the original author fifty years ago to present use. The former plan would also, we think, have been more satisfactory to the reader, who between the "author" and the two "editors" and the friends and correspondents of each of them, is in many cases likely to be misled as to the real authority quoted for a particular statement.

While, as we have already said, the general execution of the "new Yarrell" merits our entire commendation, the systematic arrangement—an unsuccessful effort at a compromise between the old fashion and the new—does not seem to deserve equal praise. No doubt the order adopted by first editor for the three groups treated of in the first two volumes placed the second editor in a difficulty. But we cannot think that Mr. Saunders was thereby justified in relegating the Steganopodes, Herodiones and Anseres to the end of the series. With these groups he should have begun the second volume, not finished the third. At the same time it must be borne in mind that the primary object was not a strictly orthodox

classification, but a good and readable "History of British Birds," and this object has, we think, been attained.

OUR BOOK SHELF

Melting and Boiling-Point Data. By T. Carnelley, D.Sc., F.C.S. Vol. I. (London: Harrison and Sons, 1885.)

THIS is a very large and important work, and one which cannot fail to be useful to the scientific chemist. It is divided into several parts, and contains, or rather consists of, tables of the elements, inorganic and organic compounds, their constitutional and empiric formulæ, melting- and boiling-points, and the authority and references to the journals, &c., in which the data are given.

The compilation of a work of this nature necessitates an enormous amount of labour and care, which in this case seems to have been expended, for misprints or misquotations appear to be absent.

It is the only one of the kind in English, although there are several German works of the same class, notably one by Richter, but of carbon compounds only. The only fault possible to find with a book like this, designed for use in the laboratory more than anywhere else, is its large size.

The present volume, the author tells us, contains 19,000 data, melting- and boiling-points, and with the second volume there is to be a total of about 50,000 data of this kind.

American Journal of Mathematics, Pure and Applied. Published under the auspices of the Johns Hopkins University. Vol. vii. Parts 2, 3, 4. (Baltimore: Isaac Friedenwald, January to July, 1885.)

THE first sixty-seven pages of Part 2 carry on Prof. Cayley's lectures on the abelian and theta functions, before the Johns Hopkins University (see NATURE, vol. xxxi. p. 189) to "the end of Chapter VII." Other papers in this part are "Solution of Solvable Irreducible Quintic Equations, without the Aid of a Resolvent Sextic," by G. P. Young (the same writer furnishes to Part III. "Solvable Irreducible Equations of Prime Degrees"), and "Notes on the Quintic," by J. C. Glashan. Mr. C. S. Peirce commences an article "On the Algebra of Logic," which runs into Part III.; it is in part concerned with a discussion of De Morgan's logic of relatives. M. Poincaré contributes a paper of fifty-six pages, "Sur les Equations linéaires aux Différentielles Ordinaires et aux Différences Finies." Capt Macmahon adds a short "Second Paper on Perpetuants." The Associate-editor, Dr. Craig, likewise briefly writes "On a Certain Class of Linear Differential Equations." Other short items in this part are: "Prüfung grösserer Zahlen auf ihre Eigenschaft als Primzahlen," by P. Seelhoff; and "Sur les Nombres de Bernoulli" (following up a paper entitled "Some Notes on the Numbers of Bernoulli and Euler," by G. S. Ely, in vol. v.), by Prof. Teixeira, of Coimbra.

The first thirty-four pages of Part IV. are taken up with a paper by Mr. A. Buchheim entitled "A Memoir on Biquaternions," in which the author carries on his investigations in a field first opened up by Clifford. In it he aims at giving "a tolerably complete development of Clifford's calculus." Mr. J. Hammond carries on his labours on the lines of some recent papers by Cayley and Sylvester, by contributing a memoir "On the Syzygies of the Binary Sextic and their Relations." Prof. W. Woolsey Johnson writes "On a Formula of Reduction for Alternants of the Third Order," and "On the Calculation of the Operators of Alternants of the Fourth Order." Short notes are communicated by F. Franklin "On the Theorem $e^{ix} = \cos x + i \sin x$," and a "Proof of a Theorem of Tchebycheff's on Definite Integrals;" and W. E. Story supplies a paper on "The Addition Theorem for Elliptic Functions." The remaining article is an additional Bibliography of the kind of which the *Journal* has now published some three or four most useful specimens. On this occasion Messrs. Nixon and Fields have compiled eleven pages of "Bibliography of Linear Differential Equations." All such lists, if fairly complete, are bound to be most useful. The authors solicit corrections of and addenda to the list for future publication.

A Guide to the Universal Gallery of the British Museum (Natural History). By L. Fletcher. (Printed by order of the Trustees.)

THIS excellent little guidebook is worthy of the highest praise. It is a good deal more than a book which tells you the primary facts respecting the objects in the cases, inasmuch as it contains a simple and elementary introduction to the study of minerals. For such a purpose the principal crystallographic, physical, and chemical characters should be explained, and the way in which these characters serve as a means of classification should be shown. Mr. Fletcher has done this excellently. He shows how the science of crystallography grew by the discoveries of Steno, Romé de l'Isle, Haüy, and others to its present state, in which it serves as a most, if not the most, important element in the discrimination of minerals. The way in which Brewster's discoveries in crystal-optics confirmed the results of crystallographic investigation is pointed out; and a brief sketch of the progress of chemistry from the days of alchemy is also given.

This all leads up naturally to the ultimate purpose—that of classification, which is so essential in the proper display of a mineral collection. Finally, in the detailed account of the minerals in the Museum attention is specially directed to the more unique specimens.

Die Spaltpilze. Von Dr. W. Zopf. 3rd Edition. (Breslau, 1885.)

THIS, the third edition, differs in no essential respect from its predecessors. Zopf still adheres to the original proposition of Von Nägeli, that the various forms of schyzomycetes are not permanent species (Cohn), but various stages in the development of the same organism. This proposition is derived from observations of the morphological characters only, and is not based on sufficiently exact methods of *pure cultivation.*

The sections treating of the physiology and chemistry of the bacteria will be found very valuable. A complete and alphabetically-arranged bibliography at the end of the work is the best as yet published. E. KLEIN

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Evolution of Phanerogams

MUCH as I dislike controversy occasions arise when it must be faced; and Mr. Starkie Gardner's notice of the two new volumes by MM. Marion and Saporta (p. 289) calls for a reply. Personally I am obliged by Mr. Gardner's obvious desire to do justice to my views; but he must excuse me if I say that some of the "main facts" on which he relies are, like similar ones employed by the two French writers, charmingly independent of anything that I can find existing in nature.

Through the kindness of my accomplished friend, the Marquis of Saporta, I received copies of his two volumes as soon as they were published. On perusing his descriptions of the carboniferous

plants I found numerous statements with which I could not agree. Some of these statements refer to questions of facts; others to inferences drawn from real or imaginary facts. Having long enjoyed the valued privilege of a correspondence with my distinguished friend I sent to him a lengthy criticism of parts of his new volume which I thought to be seriously misleading; either because matters of fact were so exhibited as to convey erroneous impressions, and hence, practically, to become not facts—or because they were made to justify conclusions which the facts themselves, rightly stated, would not do. At the same time I gave my correspondent warning that I might have to correct what I regarded as his erroneous or misleading statements.

Mr. Gardner's article leads me to fulfil this announcement sooner than I intended, since he, in turn, has so far countenanced some of what I regard as the errors of the two French palæontologists as to make them his own. Like Mr. Gardner, M. Saporta had previously pointed out to me that the aim and object of his volumes did not necessarily involve interference with matters that have so long been in dispute between M. Rénault, M. Grand'-Eury, and myself. To this I could only reply that in his new work he had repeatedly shown his acceptance of views of these two palæontologists involving both facts and inferences, which I believe to be seriously erroneous. The space which NATURE can afford me will not suffice fully to review all of what I regard as the objectionable parts of the two volumes under consideration, but I may be allowed to make some comments, including some extracts from my letter to M. Saporta, indicating the nature of my objections both to his conclusions and to the comments made upon them by Mr. Gardner.

The latter gentleman makes one statement which I cannot endorse. Because MM. Rénault, Grand'-Eury, and Saporta all adopt the views of M. Brongniart he thinks it hardly possible that they can all be mistaken. This argument cuts both ways—Mr. Gardner applies it to the subject of Calamites *versus* Calamadendron. On this subject I may retort that when such men as Schimper, Weiss, Stur, and perhaps my prolonged investigation of the subject justifies my adding myself, take an opposite view of the matter in debate, it may possibly be equally impossible that we, with our vast array of specimens in our cabinets, should all be mistaken! This *argumentum ad hominem* therefore falls to the ground. I may be allowed to wonder that it should ever have been advanced.

The first point to which I would call attention shows that such men as those quoted may blunder and have blundered. I now refer to the subject of the relations of Lepidodendron and Sigillaria to each other and to the rest of the plant world. That I have for many years insisted upon the cryptogamic character of, and the close affinity existing between, both these genera is well known; and equally so, that many of the French palæontologists have followed M. A. Brongniart in regarding the Lepidodendra as Lycopodiaceous plants whose stems contain no exogenous vascular cylinder, whilst all those plants that possessed such a cylinder (a product of a Cambium layer) which they believed to be the case with Sigillariæ must, *de facto*, be Gymnosperms. That this dispute has now been settled in my favour by an important recent discovery does not seem to be known to Mr. Gardner. M. Zeiller has obtained strobili of Sigillaria which have settled the matter even in the opinion of most of the Parisian botanists. Those strobili contain spores, not seeds. This discovery demonstrates the cryptogamic character of Sigillaria, and deals a final blow at the Gymnospermous hypothesis held by the four observers in whose combined infallibility Mr. Gardner expresses such confidence.

My first friendly complaint against the authors of the "Evolution of the Phanerogams" is that they disregard proven facts when such facts inconveniently oppose their theories. *Imprimis*, they became aware of M. Zeiller's important discovery whilst their volumes were passing through the Press. Though this is a sufficient reason for only noticing it in a footnote, it does not justify their very slight recognition of its bearing upon so many pages of their arguments, of which it effectually disposes. It absolutely establishes the fact that *some* Sigillariæ, at least, are *not* Gymnosperms but Cryptogams; which fact, superadded to the many identities of structure in Sigillaria and Lepidodendron, which I have repeatedly shown to exist, renders it increasingly probable that the above statement is applicable to *all* Sigillariæ. At least, it now throws upon the opponents of that statement the onus of proving the contrary to be true, which they have not done.

Several years ago the late Mr. Binney described what he believed to be two plants—the *Lepidodendron vasculare* and the *Sigillaria vascularis*. That the only difference between these two was the possession, by the latter, of an exogenous zone, not seen in the former, was recognised by Mr. Binney. I have shown in a way, which I claim to be unanswerable, that these are one and the same plant which the external and internal characteristics alike demonstrate to be a Lepidodendron. Hence I complain to M. Saporta, "You continue to speak of *Sigillaria* vascularis. I reply that there is no such plant; and to speak of the *Lepidodendron* under that name, after all that I have done in illustration of its organisation, is unfair to me, besides seeming to support M. Rénault's absurd conclusion that an exogenous or centrifugal zone is incompatible with the possibility of a plant possessing such a zone being a Lepidodendron." I then state "further, after enumerating M. Rénault's three supposed types of Lepidodendron, from which he excludes all possibility of the existence of an exogenous zone, you say, 'ce sont les traits *essentiels* des types caulinaires Lepidodendroides.'

"I reply in language as strong as I can possibly use that this is not true. The development of an exogenous zone in the more advanced stages of a Lepidodendron's life is the rule rather than the exception."

After citing numerous proofs of this statement I say in reference to Sigillaria: "It is further a mistake to say that 'ces tiges nous sont principalement connues par les Sigillaria elegans et spinulosa.' We possess the vascular axis of the Sigillaria figured in my Memoir II., Fig. 39. This axis is identical in the minutest details of its organisation with those of the Diploxyloid Lepidodendra, and I have sections of Sigillaria reniformis which are, in structure, equally Lepidodendroid. I ask, therefore, what are the 'diversités appréciables' to what you refer on p. 23, and what ground have you for saying that this double fibro-ligneous region is 'sans analogie avec ce qui existe dans les tiges connues des Lepidodendrées'?"

On this part of the disputed questions I must object to a statement made by Mr. Gardner, in which he says that the structure of Lepidodendron "presents nothing unusual to Cryptogams." Surely a thick *exogenously developed* cylinder of scalariform vessels, arranged in radiating laminæ, separated by true medullary rays, the entire structure being produced by a Cambium zone, is very unusual in Cryptogams. Mr. Gardner then proceeds, as M. Saporta would do, to describe a contrast which has no real existence. "But in Sigillaria, a plant strongly resembling it in nearly every other respect, we find a radiating vascular or woody zone in the cellular stem with unmistakable exogenous growth. It is richly supplied with medullary rays, and, Prof. Williamson allows, presents clear evidence of interruptions to growth succeeded by periods of renewed vital activity." I allow, and never have allowed anything of the kind,[1] if this means my admission that something exists in Sigillaria that does not exist in most Lepidodendra. Mr. Gardner further represents me as believing that "the typical Lepidodendron never produced a ligneous zone." I believe the reverse of this; viz. that a development of such a zone sooner or later was characteristic of most Lepidodendra. True there are some Lepidodendra in which I have not yet discovered such a zone; but I am far from supposing that even in them such a zone will not ultimately be discovered. Anyhow the *typical* Lepidodendron can no longer be regarded as one from which this zone is absent. Mr. Gardner, after the passages quoted above, says: "In Diploxylon there is a further development, the woody zone being made up of an inner or medullary vascular cylinder either interrupted or continuous, composed of large scalariform vessels without definite order, and an outer cylinder of scalariform vessels of smaller size arranged in radiating fasciculi." What does this "further development" mean? This description is simply that of *every* exogenous Lycopodiaceous axis found in the coal measures, whether of Lepidodendron or of Sigillaria. Diploxylon, *as a genus*, has no longer any existence. The term is now useful only as an adjective descriptive of a condition of growth common alike to Lepidodendron and to Sigillaria, as well as to several other genera of Carboniferous plants. Unless I misunderstand Mr.

[1] I may here observe that conspicuous or even visible interruptions to growth are very rare amongst these coal plants. They are only very *conspicuous* in my genus Amyelon; but we also find traces of them in Stigmarian roots and in Lygenodendron. Generally these Carboniferous stems suggest the reverse of changing seasons or periodic interruptions of growth.

Gardner, he here employs words designed to suggest distinctions of organisation between Sigillaria and Lepidodendron, the existence of which I altogether deny.

M. Saporta appears to accept, without demur, statements made by M. Renault respecting Stigmaria ficoides which I emphatically reject. These statements are reactionary in the highest degree. If true they would compel us to cast overboard much of the work done during the last half century by Logan, Binney, Sir William Dawson, and a host of other observers; work, the reality of which, along with the conclusions drawn from it, was unhesitatingly accepted even by Brongniart himself. Such statements, if proven to be true, would involve a rejection of all modern views respecting the origin of coal and a return to the worthless hypotheses that were believed in half a century ago. On this subject I will at present only say that such views are absolutely irreconcilable with well-known facts. Should these views be allowed to pass unrefuted, as Sir William Dawson has properly observed, "some one will be required to rescue from total ruin the results of our labours."[1] I will at present say no more respecting these Stigmarian heresies, since I shall have to deal with them more seriously in a work now in hand for the Palæontographical Society.

Mr. Gardner makes one more statement respecting these Lycopodiaceæ that is unsupported by any evidence which my rich cabinet can supply. He say that "during growth the woody or exogenous zone increased for a certain period, but that this was quickly arrested by the absorption or destruction in some way of the Cambium layer. The *subsequent* increase in diameter took place mainly in the cortical system, and to it the growth and solidity of the stem was principally due. The exogenous element in the oldest known trees is thus seen to have been transitory and subordinate, for had it persisted indefinitely the continued generation of fresh layers or new rings of growth would have produced true Dicotyledonous stems." In the first place we have no evidence whatever of the correctness of Mr. Gardner's statement. That the vascular axis of each of these Lycopodiaceous stems was small in proportion to the diameter of its bark is undoubtedly true, and it was equally probable that the growth in the thickness of that axis was slow; but I know no facts indicating that such growth ever ceased. The diameter of each vascular axis bears about the same proportion to that of the bark, whether the stems are large or small, young or old. Hence we may fairly infer that the cortex and vascular cylinders alike continued to grow *pari passu* so long as each plant continued to live. Anyhow, I know of no facts suggesting a different conclusion.

Respecting the relation of Calamite to Calamodendron, Mr. Gardner says my evidence as to their identity is negative rather than positive. If he will honour me with a visit I think I can soon convince him that this is a mistake, and would only add that there is little possibility and no probability of Mr. Gardner's suggestions being true, viz., that I have "*not come across an undoubted Calamite*," and that such may be common in France though absent from our British deposits. We have them by thousands. What I insist upon is that they differ in no respect from the so-called Calamodendra, the supposed differences being merely due to conditions of preservation. That as soon as we get Calamites with any portion of their internal organisation preserved, they all prove themselves to be Calamodendra. And that even when their internal organisation is not preserved the marking on the surface of their thin carbonaceous covering itself demonstrates that identity. The volumes of MM. Marion and Saporta contain other statements to which, as I have informed my friend, I cannot give my assent; but what I now put on record suffices to show the general nature of the points on which we disagree. M. Zeiller's discovery has settled the questions of the existence of exogenous Cryptogams in the minds of most men—even of several of those who hitherto believed in the accuracy of Brongniart's hypothesis. Patient and persevering investigation will, in time, demonstrate which of us is right in reference to other debated questions. Meanwhile the continuance of co-operation and mutual kindly feeling, notwithstanding our differences of opinion, must be important factors in the attainment of certainty.

Manchester, July 31 W. C. WILLIAMSON

Grisebach's "Vegetation of the Earth"

IN No. 823 of your valued paper is an article by Mr. W. Botting Hemsley on the new edition of Grisebach's "Vegetation der Erde," closing with a reproof to editor and publisher for offering the public an old book as new. For my part I have to say that it was my strong desire to have a really new edition of Grisebach's classical work, which was no longer to be had in the booksellers, by one of our geographical botanists of the first rank. This, however, proved unattainable. Seeing I was bound by contract to the family of Grisebach, and the son of the deceased, Dr. Edward Grisebach, German Consul in Milan, insisted on bringing out the "new" edition himself, all entreaties, representations, and explanations were of no avail. He declared he would never trust the work of his father to other hands and that he felt himself called upon to prepare a new and improved edition. I had therefore but the alternative of seeing the work completely disappear or committing the task of a new edition to the hands of Dr. E. Grisebach, and I think no one will reproach me for choosing the first. At the worst I could only look forward to the new edition being a nearly unchanged copy of the old work (what in point of fact it is), and this seemed to me a far less evil than the complete disappearance of the work, an opinion which friendly and competent judges shared with me. W. ENGELMANN

Leipzig, August 10

[1] Address to the American Association for the Advancement of Science, p. 22, 1883.

A Singular Case of Mimicry

HAVING often read in the pages of NATURE of several cases of protection by simulation (or mimicry), I beg to mention one which has recently come under my own observation, and which, I think, ought to be registered.

I refer to a small insect which I found in a state of larva, and of a white colour, whose back (only) was covered with a layer of moss, and whose movements in this condition were so natural and rapid, that one could immediately perceive that it was the natural *modus vivendi* of the insect. The layer of moss was firmly attached to the body, and completely covered it. I made the experiment several times of placing it on its back, feet uppermost, on a sheet of paper placed on a table. After a few movements the insect, without disturbing the moss, returned to its normal position by making certain movements which resembled those of an acrobat, who, lying on his back, makes use of his hands, and, by a backward somersault, returns to his feet. The little creature is so completely disguised by this layer of moss that, on placing it on the trunk of a tree covered by the same moss, its movements are with difficulty perceived, as the moss in movement may easily be confounded with the moss of the tree. An insect or larva under these conditions could, only with great difficulty, be recognised by its natural enemies (those animals which prey on it).

I send you the specimen to which I refer, the only one I have met with, and which may, during the voyage (of thirty days more or less), die on the way, or pass through some transformation. At all events, you will be able to see the protecting cape, and determine the species, larva or insect, which it protects.

Porto-Alegre, Brazil GRACIANO A. DE AZAMBUJA

[The larva has apparently passed into the pupa stage during the voyage, and has closed the lower side of its protective covering with a silken web. If the perfect insect should emerge, we will endeavour to ascertain its name.—ED.]

Solid Electrolytes

HAVING been for some months occupied with the electrical behaviour of the compounds of copper, silver, and lead with tellurium, selenium, and sulphur, I can confirm the observation communicated to your pages by Mr. Bidwell as to the behaviour of sulphide of copper. He has constructed a primary cell with solid sulphides for the electrolytes. The smallness of the electromotive force which he has obtained is entirely due to the close proximity of copper and silver in the thermochemical series in respect to their heats of combination with sulphur. The theoretical electromotive force should be only ·05 volt.

Let me add to Mr. Bidwell's observation one of my own. If a piece of sulphide of copper is placed between platinum electrodes, a current of electricity from a battery can be passed freely through it, as it is a good conductor. But if after a time the battery is removed and the platinum electrodes are connected with a galvanometer, a current is observed. The solid sulphide between two platinum plates constitutes, therefore, a secondary cell or accumulator capable of being charged and discharged.

SILVANUS P. THOMPSON

Finsbury Technical College, August 17

Preventing Collisions with Icebergs

ALTHOUGH it is, I believe, ascertained that fogs are often highly athermanous, I would, at the same time, like to ask whether a thermal radiation method might not serve to show the presence of a large mass of ice in the neighbourhood of a ship. I venture to make the suggestion, as I know of no experiments on the degree of athermancy possessed by fogs, as tested by such an instrument as the bolometer of Prof. Langley. The use of this instrument, or even of the thermopile, in conjunction with a large reflector and an alarm circuit closed by galvanometer deflection, might be worth trial by any one possessing the opportunity.

J. JOLY

Engineering School, Trinity College, Dublin, August

Monkeys and Water

Is it a usual thing for monkeys, either in captivity or in their native condition, to take freely to the water? Some relations of mine have a small monkey that was brought to them from Java, and which is a great pet. One day it was thought that he should be bathed, and he was put on the edge of the bath. In a little while he hung down from the edge by a foot and hand, and drank the water, and then, plunging in, he swam backwards and forwards under the water, with his eyes open, with great enjoyment.

After the first time he was frequently bathed, and a day or two ago I saw him go through the performance. It was very pretty to see how he enjoyed it, swimming under the water and diving away from a hand put down to take him; then going head over heels at the bottom and lying on his back to bite playfully at a finger; then he would run about on all-fours with his head held out of the water, and then go under again: and after it all, when he was taken out and dried with a towel, he lay wrapped up in a shawl, sleeping comfortable and happy. I should like to know whether he is an exception to the rule in his love of the water.

JERRY BARRETT

15, Avenue Road, Regent's Park, August 6

A Correction

I HAVE very stupidly made it appear in my note on pitcher plants, printed in last week's NATURE (p. 341), that Dr. McBride was President of the Linnean Society in 1815. I ought to have written, "In 1815 the then President of the Linnean Society read a communication from Dr. James McBride," &c. I suppose Sir James Edward Smith was at that time President of the Linnean Society, and that Dr. McBride never was.

W. WATSON

August 15

A MODEL UNIVERSITY

THE following information for applicants for admission to the Johns Hopkins University, printed in the University Circulars in response to letters, we are sure will be read with interest and profit:—

How was the University Founded?—The Johns Hopkins University was instituted by the munificence of a citizen of Baltimore, Johns Hopkins, who bequeathed the most of his large estate for the establishment of a University and a Hospital. The foundation of the University is a capital, in land and stocks, estimated in value at more than 3,000,000 dollars; the capital of the Hospital is not less in amount. The University was incorporated under the laws of the State of Maryland, August 24, 1867, and it was opened for instruction in September, 1876. The Philosophical Faculty (of Letters and Science) is now organised. A medical department will soon be instituted.

In what is Instruction Given?—Systematic instruction is offered in English, Anglo-Saxon, German, French, Italian, Spanish, Latin, Greek, Sanskrit, Hebrew, Arabic, and in other languages and literatures; in pure and applied mathematics; in chemistry (inorganic and organic) with laboratory work; in physics (including mechanics, light, heat, sound, electricity, magnetism, &c.), with laboratory work; in biology (including physiology and morphology) with laboratory work; in mineralogy and geology; in ancient and modern history; in physical geography; in political economy and in the elements of international law; in logic, ethics, psychology, pedagogics, &c. Occasional courses of lectures are also given upon special themes in literature, science, history, archæology, art, &c.

To whom is this Instruction offered?—To all young men who are prepared to profit by it and who will conform to the simple regulations which are established by the authorities. Graduate, Undergraduate, and Special Students are received.

Those who have not already received an academic degree, should aim to secure one by pursuing a liberal and prolonged course of study, at the close of which the degree of Bachelor of Arts will be conferred. Those who may be prevented from seeking this degree will nevertheless be welcomed to the University, provided that they are in earnest and are mature enough in years, attainments, and character to profit by the advantages which are here afforded. Others who have already taken their first degree are encouraged to go forward in advanced lines of work, and for them unusual facilities are provided. Young men who are to pursue the study of law, medicine, or theology, or who have entered upon professional lives, and others who expect to become teachers, if they desire to become proficient in literature and science, have easy access to the class-rooms and laboratories. The degree of Doctor of Philosophy may be obtained, after three years of advanced study, by those who have met the required conditions.

How is this Instruction given?—By all the methods which experience has shown to be useful—varying according to the preferences of the teachers, the subjects taught, and the number of scholars. There are recitations, lectures, conferences, prolonged courses in laboratories, exercises in special libraries, personal counsel, study of nature out of doors. The usual four-year classes are not maintained, but in all the principal subjects taught there are beginners, intermediate students, and advanced workers; so that every scholar is assigned to that position in each section of the University which will yield him the greatest advantages. He may be far advanced in one subject and only a beginner in another. This result is only secured by the engagement of a large staff of teachers.

What are the Laboratory and Library Facilities?—The scientific laboratories are three in number. They are open throughout the day and are fully equipped. For chemistry there is a special building arranged for about ninety workers, and well adapted to all kinds of chemical and mineralogical work. A large building has been recently constructed for a biological laboratory, with complete arrangements for physiological and morphological work. The physical department is furnished with apparatus selected both for demonstration and investigation, and especially valuable for researches in electricity, magnetism, light, and heat. The construction of a new building for a physical laboratory is now under way.

The library includes over 26,000 bound volumes, and 650 serials are regularly received. It is open thirteen hours daily. The library of the Peabody Institute, with 80,000 volumes, and the other Baltimore libraries, are of easy access. Washington is so near that the Library of Congress, the National Museum, and the other libraries and museums of the capital may be readily visited.

What are the Necessary Expenses of a Student?—The charge for tuition in all departments (including the use of the library, and without any extra charges except for materials consumed in the laboratories), is 100 dollars per annum, payable one-half October 1, and the other half February 1.

Young men living in any part of Baltimore, or in the immediate vicinity, can lodge at home, as the first lessons

are given at 9 a.m. daily, and there is rarely any required exercise as late as 5 p.m. Young men from a distance can readily find rooms and good board either in private dwellings or in boarding houses. It is possible to secure accommodations (room and board) for 5 or 6 dollars per week, and for a sum between 6 and 10 dollars per week it is still easier to be suited. The other necessary expenses of life are moderate.

Are there any Scholarships?—In accordance with the request of the founder of the University, twenty Hopkins scholarships, giving free tuition, are annually conferred upon matriculated undergraduate students from Maryland, Virginia, and North Carolina. In addition to these scholarships, eighteen honorary Hopkins scholarships, yielding 250 dollars and free tuition, are offered to those collegiate students from the three States above-named who pass the matriculation examinations with the most credit. Two scholarships giving free tuition are also open to matriculated students from the district of Columbia. Twenty scholarships yielding 200 dollars, and twenty fellowships yielding 500 dollars are annually open to graduate students.

What Special Opportunities are offered to University Students?—Advanced and graduate students are received with or without reference to their being candidates for a degree, and they are permitted to attend such lectures and exercises as they may select. They are not examined for admission to the University, but each instructor satisfies himself of the attainments of all who wish to follow his guidance before admitting them to his classes.

Systematic courses of instruction, varying every year, are announced in the annual programme. The professors are free to give personal counsel and instruction to those who seek it; books and instruments adapted to investigation and advanced work have been liberally provided; the system of Fellowships secures the presence of twenty special students imbued with the University spirit, most of them looking forward to academic careers; seminaries limited to a few advanced students under the guidance of a director have been organised in various subjects; societies devoted to philology, to mathematical, physical, and natural science, to metaphysics, to history and political science, and to archæology, afford opportunities for the presentation of memoirs and original communications, and there are also clubs for the reading and discussion of biological, physical, and chemical papers; during the year courses of lectures are given by resident and non-resident professors on topics to which they have given special attention; the libraries of the Peabody Institute and Maryland Historical Society, founded for the advantage of scholars, are easily accessible; the issuing, under the auspices of the trustees, of publications devoted to mathematics, chemistry, philology, biology, and history brings the University into advantageous connection with other foundations; special libraries connected with the seminaries bring the most important works within easy reach of the student, and the University reading-room, which is constantly open, is liberally supplied with new and with standard books and with the literary and scientific journals of this and other lands.

On what Conditions is the Degree of Doctor of Philosophy Conferred?—The degree of Doctor of Philosophy and Master of Arts is conferred upon candidates who (after having taken their first degree) have pursued University studies, for three years, under approved conditions, have passed the required examinations and presented a satisfactory thesis. At least the last year of study must be spent in this University.

How are the Fellowships Awarded?—Twenty fellowships are annually open to competition, each yielding five hundred dollars and exempting the holder from all charges for tuition. A statement of the rules governing the awards will be sent if requested. Applications for the next year must reach the University before May 1, 1886.

Is there what is commonly known as a College Course? There are seven parallel courses, by following any one of which a matriculated student may attain the degree of Bachelor of Arts. This plan combines the advantages of choice and restriction. From the variety of courses laid down, the scholar elects that which he prefers; having made his choice he finds a definite sequence of studies provided for him. The University marks out for those who elect a classical course, such a plan for the reading of Latin and Greek authors, sometimes with a teacher and sometimes privately, as will enable all who follow it to excel in these studies, while it requires that they should also learn to read French and German, and pursue during one year a course in science. It likewise provides a training which is mainly scientific, enabling the student to concentrate his attention chiefly on chemistry, or biology, or mathematics, or physics; but with these studies he must combine the study of languages, history, and philosophy.

Every matriculated student is expected to follow, under the guidance of an adviser to whom he is specially assigned, one of these prescribed courses which are fully described in the Register. Some elect the classical course. Others may concentrate their main attention upon the higher branches of mathematics. Courses are arranged also for those who wish to devote themselves chiefly to chemistry and physics. For those who expect at a later day to take up the study of medicine, there is a special course marked out, in which biology is the dominant subject. Arrangements are also made in other courses for the study of history and political science and of the modern languages and literatures.

What is required for Admission to the College Courses?—Undergraduates who wish to enter, either as matriculates, candidates for matriculation, students in the preliminary medical course, or as special students, must begin by satisfying the University that they have been thoroughly taught the English studies which are usual in good high schools, academies, and private schools, including a knowledge of arithmetic (with the metric system); geography, physical and political; the outlines of the history of the United States; English grammar and composition. The candidate for matriculation must also pass an examination in—

(1) Latin; (2) Greek (or French and German); (3) mathematics (algebra, geometry, trigonometry, analytical geometry); (4) English; (5) history; (6) natural science. Those who do not intend to follow the classical course may offer French and German instead of Greek. A student may be admitted, under certain circumstances, without matriculation.

Can a Student be aided in Completing his Studies for Matriculation?—If a student at his admission passes in a considerable part of the matriculation requirements he may postpone the remainder for a time. If he is well up in algebra and geometry he may join the University classes in trigonometry and analytical geometry; if he is a good scholar in Latin and Greek, but has not read all the authors requisite for matriculation, he may receive instruction in these authors from the University; if he has not already acquired the elements of French and German he will be aided in doing so, in order that he may enter the courses here provided.

THE HARVARD PHOTOMETRY[1]

WE have waited for the second part of this very remarkable volume completing the Harvard Photometry, rather than examine the separate portions piecemeal. There can be no doubt that its appearance is associated with an epoch in the general progress of astronomical science, coincident nearly with the other

[1] Constituting Parts 1 and 2 of vol. xiv. of the *Annals* of the Astronomical Observatory of Harvard College. (1885.)

corresponding advances in connection with the spectroscope and sidereal photography. The three combined constitute a distinct feature in the more modern methods, by which we are gradually becoming better acquainted with the infinite remote. So soon as molecular physics shall have made, as is promised, a like advance, then the infinite minute also will be brought more distinctly within the human ken.

With regard to the Harvard volume on Sidereal Photometry, without unreservedly conceding to it all the accuracy to which it lays claim, it must be gratefully acknowledged that it provides astronomers with a consistent and valuable catalogue of stellar lustre which, in a complete form, had not hitherto existed. It dispenses with the too often unreliable and discordant estimates of the past, and replaces them by scientific measures possessing, to say the least, considerable precision.

The two parts of the volume contain together no less than 512 closely-printed pages, many of them abounding with models of condensation, and constituting in themselves a remarkable instance of sustained and successful scientific labour. They embrace not only the general history of the subject to which the volume refers, but they at the same time combine elaborate criticism and valuable comparisons of the results of preceding labourers in the same field.

In the first part there is given a description of the meridian photometer, with which the measures of comparative lustre of the stars are obtained. In it are most ingeniously combined the more valuable and least dangerous devices which are found in the instruments devised by Sir John Herschel, Steinheil, and Zöllner. Taken as a whole, the instrument may be properly regarded not only as ingenious but as original. Roughly speaking, it consists of two contiguous telescopes placed horizontally nearly in the meridian, each of the object-glasses being armed with a reflecting prism, so that the light from Polaris and any other star may be brought into the same field of view, after having passed through a double-image prism. The images are then viewed through a Nicol prism, and, by means well known to physicists, the light of the one star is reduced by a measurable amount until it is adjudged to be equal to that of the other star.

We trust we may be pardoned if we suggest that this construction of the instrument may possibly be too complicated to admit of that amount of precision in the measures which could be desired, and which might be obtained by simpler means. In fact, it appears from the volume itself, that at the commencement of operations, it was necessary to abandon the results of several months' work with it; and although an improvement in the use of it was subsequently adopted, we think there still remain traces of the possibly inherent difficulty of precise adjustment. The rapidity also with which the equalisation of brightness of each star with that of Polaris is made, seems hardly consistent with the requisite precision. It is to be inferred from the volume itself that as many as forty-eight final determinations, each consisting of four equalisations of the light of a star with that of Polaris, are frequently completed within the hour, in addition to the consumption of time required for finding and identifying the successive stars and adjusting them in the field of view. But, we cannot doubt, this point has been well considered by the Harvard astronomers themselves.

In the determination of the magnitude of a star, it is the usual practice to rest content, generally, with the mean of three determinations. Each determination is made on a different night, and consists of the mean of four equalisations of the lustre of the particular star compared with that of Polaris in the field of the photometer. We venture to think that the general limitation to three only is too restricted for the purposes of accuracy. The reason for this opinion is derived from the fact that on examining the numerous cases in which as many as fifteen determinations of magnitude are made on as many nights, it is very frequently, and in fact generally, possible to find three consecutive determinations which would of themselves, in the mean, lead to a magnitude widely different from that ultimately assigned. Yet these three consecutive sets furnish no circumstance of inter-discordance among themselves which could lead to suspicion, and which might, consistently with the usual practice, have finally settled the magnitude of the star in question. We regard this not as hypercriticism, but as being the only sufficient means at hand for the examination of accuracy furnished by the volume itself.

Independently of the several catalogues containing the results of three years' unremitting labour and persevering skill, the volume abounds with the intercomparison and reduction to one scale of the work achieved in a similar direction by many preceding astronomers. The result is that astronomers who are desirous of information on the subject of stellar brightness, will probably not be disappointed if they turn to the pages of the Harvard Photometry. Combined with a memoir by Prof. Pritchard, contained in vol. xlvii. of the *Memoirs* of the Royal Astronomical Society, it is perhaps not too much to say that all that is known upon the subject up to the present date will be found easily accessible to the student.

Towards the conclusion of the volume Prof. Pickering has drawn up a very important table, which, though short, must have given him very considerable labour to compute. It contains in one summary a critical comparison of the average results of all the principal catalogues of stellar magnitude hitherto published. The Harvard Photometry is taken as the basis of the comparison, and the difference between the mean or total results of each catalogue and that of the Harvard volume is given. From the inspection of Table lxxxiii. it appears that, taken as a whole, the Harvard measures indicate in the mean a brightness of the stars compared greater than that indicated by the estimates in the *Durchmusterung* of ·14 mag., brighter than the mean of the Uranometria Nova of Argelander by ·10 mag.; of Heis by ·12 mag.; and of Houzeau by ·11 mag. These differences, it will be observed, are all in one direction, and might appear to indicate that there is a generic difference between estimates of star magnitude by the unaided eye, and measures carefully made with a photometer such as is the meridian photometer at Harvard College, because all the estimates are apparently fainter than the measures. But this can scarcely be the true explanation, since the photometric measures also of Seidel, Zöllner, and Peirce indicate, like the eye estimates, a brightness less than that of the American determinations. Moreover, the photometric measures made by Prof. Pritchard at Oxford agree in the mean of the whole, very closely with the eye estimates in the *Durchmusterung* and the other catalogues. But, whatever the significance of this fact may be, it cannot be doubted that the Harvard volume will ever remain a most valuable addition to our knowledge in an important branch of astronomical science.

U.S. INDUSTRIAL STATISTICS[1]

TO all who study anxiously social science, this is a very promising publication; its indirect testimony to the advantages of Republican institutions will be weightier to any reflective man than the eloquent tirades that are so usually bestowed upon them. It defines its object to be the stimulation and assistance of the wage-worker in his endeavour to reach a higher position. Its information respecting working men is all taken from their own contributions, a dozen pages of small print being filled with verbatim quotations from the replies of workpeople in every trade in the State, who give such

[1] "Sixth Annual Report of the Bureau of Statistics of Labour and Industries of New Jersey," 1883." Trenton: New Jersey, 1883.

varied accounts of themselves that the independence of the testimony cannot be doubted. That its work is popular is indicated by the wish expressed by one of them that "there should be a National Bureau." Factory legislation is printed in it (even 1884 legislation, although the printer's date is 1883!); the factory inspector has become a popular institution, and much testimony is borne to the smaller hardship of factory laws uniformly than loosely enforced. The more educated and more prosperous workmen are, the more ambitious and aspiring they become, and we seem on the eve of their blending with their masters when complaints are made, as here, that many of their fellow-workmen are satisfied with *only* 66 shillings a week wages; and a caution is held forth to such not to spend their money in foolishly aping the rich.

Yet, though the teacher here is no longer one of the fatherly governments of the old world using his paternal authority for the good of a rather refractory son, yet the teaching is most satisfactorily similar. Drunkenness could not be set forth as the prevailing cause of pauperism among the men or the evil of a lack of artistic taste among the masters in more vivid or unqualified terms than they are here. The sad combination of progress and poverty is bewailed, but we fear that co-operation urged here as its remedy too much overlooks the control of fashion and its effect upon supply and demand. A most practical power put in the hands of this Bureau is that of examining the accounts of co-operative companies. Any five members of a company may require such an examination.

The principal industries of New Jersey are taken, and, after full statistics of their amount, prosperity and prospects, with the wages earned by each class of workers, an interesting account is given, commencing with a short history of the methods, improvements, and general position of the trade in the United States and in other countries, and their experience compared. Any one casting about for an occupation in which he could take a satisfactory part would find in this "Book of Trades" much to supply the information first required, and much to encourage him. Among them we find a review of the silk trade, which, under the ægis of 60 per cent. duty, has made the wealthy city of Paterson; of glass-making, which at present does not extend much beyond window glass and bottles; of the cultivation of sorghum, still in its infancy in New Jersey; and of the pottery trade—after its account of which it performs the very useful function of a publication like this of appealing to such a trade to take the steps necessary for raising their standard of art. An appeal is made, not from a Government department, or from an interfering *clique* as South Kensington is occasionally regarded as being, but by the organ of his late fellow-workers, that the maker of one of those large fortunes so common in America will, for his country's glory and their help, found a technical school; while hands are led to feel that intellectual training and not mechanical energy alone is wanted. The idea is shown here also to be making its way that the school should be made the basis of technical as well as of mental training; that the dextrous use of the body should form part of the school, as well as of the playground, teaching. More than this, it is felt that they should not be two so distinct branches of education as in past days, and that the members and muscles of the body, as well as the brain, should receive elementary instruction at the school, and that the former should be placed more deliberately under the control of the latter. It is felt in America that

> "The cultured mind
> The skilful hand"

ought naturally to go together, and not that one should be the usual mark of the absence of the other; that, therefore, a mechanic should not mean little more than a machine, but a mechanician, able to understand, make or repair the giant body that is using its limbs to save his exertions, and therefore a man more on a level with other men whose time has been given to the cultivation of their minds only, and more justified in insisting upon their equality with the latter. It is urged in this Report that elementary technical knowledge valuable to all the New Jersey trades may be given in ordinary schools; that technical learning is popular, frequently most so to boys who are slow at books; and that successful manual occupation improves the morality of the worst of such boys.

A very favourable notice of the Reformatory school at Coldwater; a sad tale of jail arrangements, and of methods of keeping the poor, all lead to discussions of economical difficulties felt long ago in England, not by any means avoided in America, and showing how little forms of government can modify human nature. A more hopeful view of that is afforded by the account, illustrated with three engravings and three plans, of a working-man's Institute at Millville. At this one establishment, which seems to have cost little more than 4000*l*., are combined, besides large grounds used for field sports, bicycling, &c., a gymnasium and baths in charge of a barber in the basement, while on the ground floor are a conversation room hung round with maps and supplied with musical instruments on which performances are given, where also lectures are delivered, discussions held, and games of skill played. Side by side with it is a library and reading-room. Up stairs are four class-rooms and a large hall seating 500 persons, besides a gallery over the rear half of it. At the other end of it is a stage with two dressing-rooms and other necessary adjuncts. This room is used on Sundays as well as on weekdays by various societies—a choral class among others—and is a convenient source of revenue.

It is impossible to lay down our Report without feeling that if each department of its work is by itself of little importance, it will doubtless be a useful agent in making every inhabitant of New Jersey and of the United States a more intelligent worker at his trade or surveyor of the economies around him.

PIERCING THE ISTHMUS OF PANAMA[1]

THREE years ago the work of cutting through the Panama isthmus had barely commenced. The equatorial forests on the neck of land, 73 kilometres long, which marked the axis of the future interoceanic canal, had hardly been laid bare. The traveller who followed the primitive road met here and there some groups of cabins, with roofs of branches on poles, marking the site of a sounding or the improvised dwellings of a portion of the operators. Culebra, Emperador, Corosita, and Gamboa, which are now full of activity, were then almost desert, and on the coast of Colon alone the excavator traced in the marshy plains of Gatun his great track. The contrast to-day is great: a long file of workshops covers the space between the Atlantic and the Pacific. Twenty thousand workmen toil on the Cordillera, making the deep cutting for the canal. Side by side with this army, another more powerful army of colossal machines, excavators, dredges, locomotives, waggons, all the materials for transport, thousands of pairs of wheels, hundreds of kilometres of rails, mountains of coal, and shiploads of dynamite. Among the twenty-five workshops of the peninsula the attention is chiefly attracted to two points: the great rocky cutting at Culebra, which is to penetrate to a depth of 120 metres into the Cordillera, and the dam of the Chagres at Gamboa. At Culebra the previsions of M. de Lesseps have been realised: the mountainous mass which the canal will traverse is, for the most part, composed of rocks which are not very hard; repeated soundings by means of diamond perforators have shown that down to a

[1] Abstract from *La Nature*.

considerable depth the rock takes the form of schists in horizontal strata. There is no doubt that it can be cut through with rapidity; it is a matter of perforation, either by mining and ordinary explosives, or by shafts with larger quantities of some explosive to displace great masses. Here 30,000 cubic metres of rock have been displaced by an explosion of dynamite; and unquestionably this colossal channel connecting two seas may be executed by simple methods and with economy.

At the end of the great cutting of Culebra, 6 kilometres from Emperador, is the great workshop for the dam across the Chagres. This gigantic basin, containing about 1,000,000,000 cubic metres of water, the surface of which is 60 metres above the water of the canal, has a bank, the content of which is 7,000,000 cubic metres. The volume of water kept in by this exceeds a hundredfold that of any reservoir in the world. By means of this work inundations in the river are prevented, currents impeding navigation and introducing rough water into the canal are avoided, and there is no fear of the accumulation of alluvion in the bed. By regulating the flow of the Chagres and of the neighbouring streams, the dam at Gamboa assures the regular service of the canal. The method of constructing this work of proportions without precedent in the annals of public works is a very simple one. From the great cutting at Culebra, near Gamboa, and the neighbouring cuttings, about 50,000,000 cubic metres of rock are removed, while only about 7,000,000 are required for the Chagres dam, and therefore the work is one of transport only—a colossal one, it is true. Even the site of the dam is formed naturally by the disposition of the bed of the torrent, which is contracted at this place between the hills of Obispo and Santa Cruz, which are distant about 150 metres from each other, and on which will rest the front wall of the great reservoir. Behind this first barrier will be thrown, as they are taken from the Cordillera, the 7,000,000 metres of rock, and the dam will be complete. The originality of the project is that, strictly speaking, there is no masonry at all in this enormous mass of rock of all sizes and shapes; the accumulation alone gives the mass firmness. The plan given here enables us to follow the sinuous course of the Chagres River. Like all torrents, and especially all torrents in equatorial regions, it is subject to considerable variations in its flow, and to enormous and violent floods. In winter its flow is 1600 cubic metres per second, while in spring it is barely 13 metres. Its tributaries, or *rios*, are of the same character—the rio Trinidad and the rio Gatuncillo have a flow in winter of 400 cubic metres. It would be impossible to divert these impetuous masses of water into the canal without producing currents and deposits and impeding the navigation. The overflow of exceptional floods will be conducted to the sea by secondary water courses. These latter, which vary in breadth from 8 to 12, and even to 40 metres near the Atlantic, are easily made by utilising the portions of the bed of the river situated on the same bank, and connecting them by appropriate trenches. The enormous reserve behind the dam will flow regularly in this new bed. Of course, the bed of the canal will be completely protected from these deviating waters, in the trenches by the slopes of the latter, and in the lower parts by banks which will soon be covered by a vigorous and indestructible tropical vegetation. With the construction of this reservoir, assured by the clearings from the cutting, and the water regulated and controlled by these courses, the work, like that of the cutting at Culebra, is only one of time. One objection which was raised when the public became acquainted with the almost incredible magnitude of the work, in which a reservoir becomes a great lake, was that this latter might itself be filled up with the alluvial deposits, which it was constructed to keep out of the canal. It is true that in its tropical floods the Chagres carries along a large quantity of alluvion; but this, which would be an insuperable obstacle in the canal, becomes a secondary consideration in the reservoir. It has been calculated by the chief engineer to the work that the Chagres can bring into the lake in *a thousand years* 30,000,000 cubic metres of alluvion, while the cubic content of the lake is 1,000,000,000 cubic metres.

Culebra and the dam at Gamboa have always been the two principal points, the main obstacles to the canal. But there are thirty-five other principal working stations, all connected with the railway between Colon and Panama. As the illustration shows, they are sufficiently near to each other to be considered uninterrupted. Fifty excavators and ten dredges work at the canal. Up to the twenty-fifth kilometre we meet with dredges, at first at Colon for the port, then at Gatun. As far as the Panama Plain there are more than sixty excavators. In the three workshops at Culebra are now installed the contractors who cut the canal from Amsterdam to the North Sea. At Corosal, at the sixtieth kilometre, the great port for access to the canal from the Pacific is to be placed, and there the great American dredges work in the swampy ground. It has been calculated that the work done up to the present is half that required to complete the undertaking, and that this new maritime route to the East will be opened in 1888.

The work stands at present in this position: it involves in all the movement of about 100,000,000 cubic metres of rocks of varying consistency. Of this, 70,000,000 are to be raised, according to the contracts, in successive instalments in 1885, 1886, and 1887. The remaining 30,000,000, which form the actual canal, will be raised at the expiration of this time either by the same contractors or by new ones. Knowing the amount already raised, the contract periods for raising a certain other quantity and the amount remaining to be done at the end of the present contracts, we can, by a sum in simple proportion, calculate when the whole should be completed. In 1888 it should be ready for traffic. This simple programme could only be applied to a work so colossal after a long and laborious period of minute study and preparation. The period of installation is always the most important in all these vast enterprises: the study and command of the appropriate material, the reception, testing, arrangement of the machines, the construction of the workshops, accommodation for the workmen, &c.; it is only when all these have been completed, when all have been made ready for work and tested, that the real work can commence, and that progress becomes sensible. This period of installation lasted, for example, in the case of the St. Gothard tunnel, for fifteen months; but the Panama canal calls for ten times more capital than the tunnel, it is executed in a country which has first to be cleared of a luxuriant tropical jungle, thousands of miles away from all industrial centres. The preparation for this gigantic work under these circumstances was a most important fraction of the work, and it is the opinion of competent men that what has actually been done during the installation period now brought to a close is equivalent to half of the work necessary to achieve the canal. In the case of the Suez Canal, 70,000,000 cubic metres had to be raised; of these, 50,000,000 were raised in two years after the apparatus had been put in working order. Seventy million cubic metres must be raised by the drags and excavators of the twenty-one principal contractors; 18,000,000 are to be raised by August 1 of the current year. These 21 contracts represent an outlay of about 240,000,000 francs, of which 65,000,000 have been tendered by French contractors; 55,000,000 by Americans; 20,000,000 by Italian, Swiss, Swedish, and natives, and 90,000,000 by an Anglo-Dutch Company. All nations are working therefore at the task. The French contractors are at work at the cutting at Emperador; the Anglo-Dutch Company has to remove 13,000,000 cubic metres in the great cutting at Culebra. Practically

the whole isthmus is being attacked simultaneously. Fig. 4 represents the work at the station of Emperador. It is connected by rails, on which locomotives run with other stations, and with the Colon-Panama Railway. The material taken out is conveyed to the great dam, which is to keep in the water of the Chagres River. The cutting at Emperador is 200 metres wide in certain places. Next to this comes the great station of Culebra. These two stations are represented in the accompanying sketches. While all this work of dredging and excavating, making cuttings and embankments is going on at the canal, the two ports of entry on the Atlantic and the Pacific are being constructed. At Colon, powerful dredging works are opened. A pier, protected on the western side by a mole, has been built, on which a new town, Christopher Columbus, is growing. On it are placed the workshops, stores, railway stations, &c. All the constructions are connected with the rail-

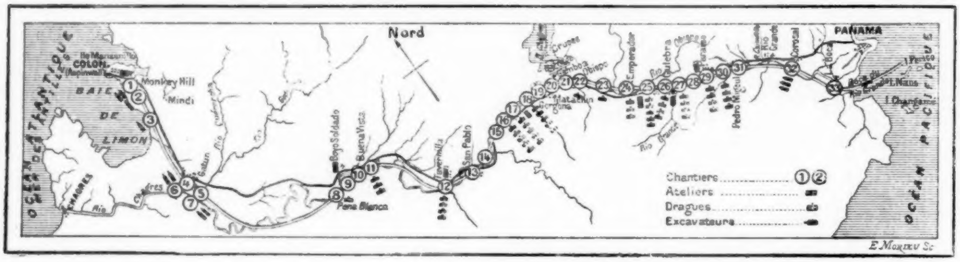

Fig. 1.—Line of Canal and works in course of execution. 1, 2, dredgings of the Port of Colon; 3, 4, 5, dredgings between Colon and Gatun; 6, 7, deviation of Rio Trinidad at Gatun; 8, dockyard of Pena Blanca; 9, 10, embankment of Bohio Saldado; 11, Buena Vista; 12, Tavernilla; 13, 14, San Pablo; 15, 16, 17, Gorgona; 18, 19, Matachin; 20, Gamboa embankment—the great dam; 21, Cerosita; 22, Upper Obispo; 23, the Obispo; 24, Emperador; 25, El Lirio; 26, 27, 28 La Culebra; 29, 30, Paraiso; 31, Pedro Miguel; 32, Corosal; 33, Boca Grande.

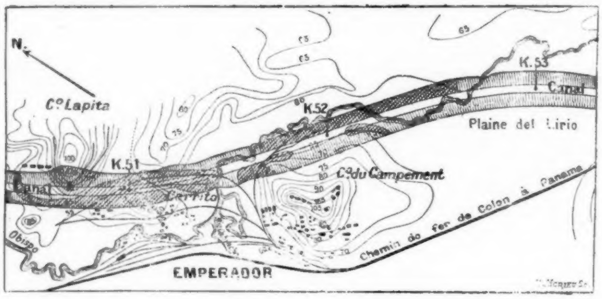

Fig. 2.—Emperador Docks.

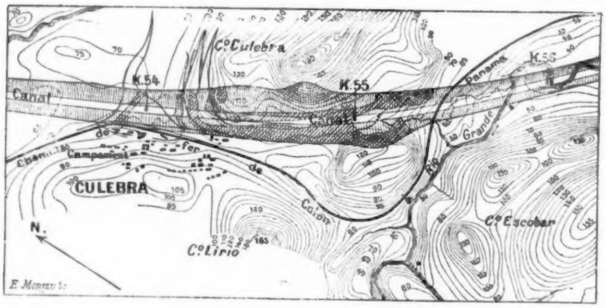

Fig. 3.—Culebra Docks.

way across the isthmus by a series of branches. Vessels drawing any amount of water can discharge at the wharf projecting into the sea, and completely protected from the wind. On the Pacific coast, the creation of a port at the mouth of the Rio Grande presents no technical difficulties, and six dredges are now at work making a channel 100 metres in width to the sea. A special organisation has been created to deal with the vast material, its employment, and repair. The isthmus has been divided into three sections, with a centre at Matachin, at the foot of the great embankment and the cutting. Here all the material is concentrated, all the repairs executed, and all the machinery put in working order. The railway of the isthmus is now the property of the Canal Company, and facilitates greatly this movement of the machinery on which the regular working of the various sections depends. By its means each working station is in communication with the central one and with every other.

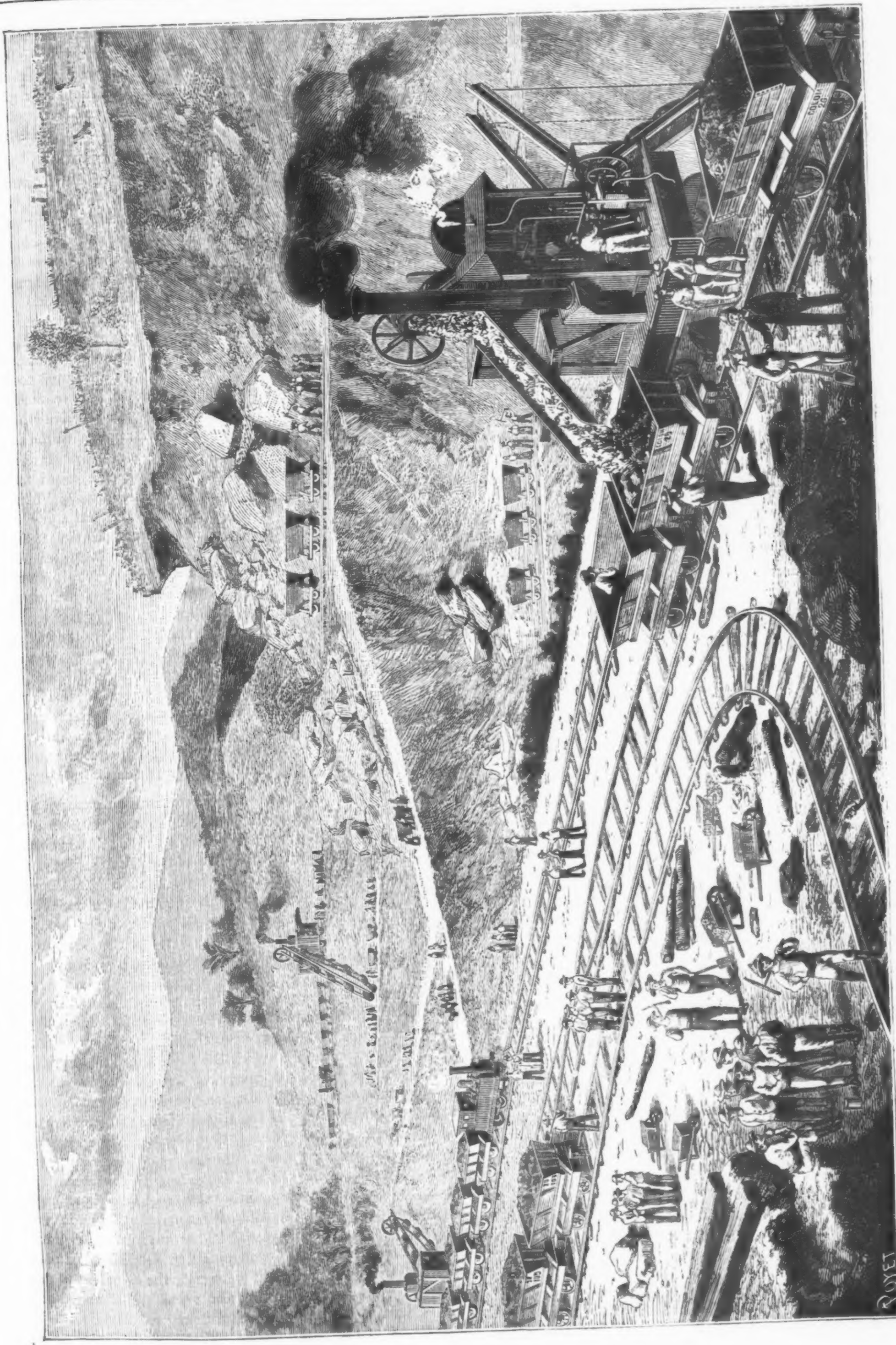

FIG. 4.—Excavations at Emperador Docks

To sum up, more than two-thirds of the work of making the canal is now in execution, under formal engagements with contractors. The problem of the canal has been solved in principle. The period of installation or preparation has been succeeded by one of execution, based on a definitive programme, accepted by those who must carry it out, the Company itself maintaining an attitude of rigorous surveillance.

NOTES

THE fifty-eighth meeting of the German Association of Naturalists and Physicians will this year meet at Strassburg. Notices of communications and abstracts of papers should be sent to Herr J. Stilling. The meeting will commence on Thursday, September 17, and terminate on September 23,

THE local committee of the American Association has issued its second circular containing the general programme of the meeting at Ann Arbor. The meeting will be called to order on Wednesday, August 26, at 10 a.m., when Prof. Lesley will resign the chair to President-elect Prof. Newton of New Haven, and the usual addresses of welcome will be delivered. In the evening Prof. Lesley will give his presidential address. On Thursday evening the citizens of Ann Arbor will tender a reception at the Court House, and on Friday it is probable that a lawn party will be given on the University grounds. On Saturday a long excursion, as previously announced, will take place; on Monday a short excursion for the members of the Botanical Club has been planned, probably to the Tamarack swamp, one of the detached spots common in Southern Michigan where a northern flora has lingered under favourable conditions through the various climatic changes of later geologic times. It is probable that similar trips to points of local interest may be arranged for some of the sections. The chairman of Section C announces that the following subjects have been chosen for discussion: first, what is the best initiatory course of work for students entering upon laboratory practice? second, to what extent is a knowledge of molecular physics necessary for one who would teach theoretical chemistry? In the discussion in Section D, mechanical science, of the best method of teaching mechanical engineering, in order that what is read and said may be to the point, the following classification should be observed: (*a*) schools of mechanical engineering; (*b*) mechanic art schools for the education of superintendents, foremen, &c.; (*c*) manual training-schools. The distinction between "mechanical laboratory practice" and "shop practice" should also be made and appreciated.

THERE seems to be no doubt that Sir Nathaniel Barnaby is about to close his connection with the Admiralty as Director of Naval Construction. We shall be interested to see in what manner the new Government fills up the vacancy, and what treatment they give Sir Nathaniel's successor, who, it is rumoured, may be Mr. W. H. White. As is known, Mr. White some time ago resigned his connection with the Admiralty for a far more lucrative post in Sir W. Armstrong's works. "But there is a difficulty in the way," as the *Pall Mall Gazette* puts it. "Private firms can pay, and do pay, their chief constructors twice, three, and four times as much as the Admiralty. Perhaps Mr. White may consent to sacrifice some thousands a year for the honour and glory of serving his country, but the time will come when scientific skill, like other commodities, will have to be purchased at the Admiralty at its market rate." Perhaps a Conservative Government will show itself more alive to this aspect of the post than its Liberal predecessor.

DR. PAGENSTECHER, of Hamburg, has just described a new form of Frugivorous Bats from a specimen transmitted to the Natural History Museum of that city by Herr H. Soyaux, of Gaboon. *Megaloglossus woermanni*, as this new mammal is proposed to be called, is remarkable as belonging to the long-tongued division of the Pteropine Bats, which was not previously known to occur anywhere within the Æthiopian region. *Megaloglossus* is closely allied to *Macroglossus* and *Melonycteris*, and in some characters is intermediate between these two genera. In its dentition it also exactly resembles them.

WE are informed by Dr. G. A. Guldberg, of the University of Christiania, that the fishery of rorquals or fin-whales (*Balænopteræ*) established at Vadö in East Finmarken, for commercial purposes, continues to be turned to good account for scientific investigation. This year Dr. R. Collett, the well-known Norwegian naturalist, is visiting the place, and has already made many interesting observations upon the structure and habits of Rudolphi's whale (*Balænoptera borealis*), which has been captured in considerable numbers during the latter part of July, although the great blue whale (*B. sibbaldii*), generally so numerous, has not yet been seen upon the coast. This is attributed to the absence of the *Thyssanopoda inermis*, a small crustacean on which the blue whale feeds. Rudolphi's whale is called "seje" or "cod" whale by the Norwegians, as it appears on the coast at the same time as that fish, but its food is also a crustacean of a still smaller species than that which is the chief nourishment of its gigantic relative. It usually visits the coasts of Finmark between the months of May and August, and has lately been taken several times on the east coast of Great Britain (Firth of Forth, 1872; River Crouch, Essex, November 1883; mouth of the Humber, September 1884). Dr. Guldberg gives its average length as 40 feet, but says it sometimes attains 50 feet. Its shape is more elegant than that of the commoner species, *B. musculus*, which it otherwise resembles. Its colour is black, and does not show the bluish tint seen in the latter species and in *B. sibbaldii*. The sides are spotted with white, and the under parts are white with a faint reddish tinge. A new use to which the whales killed at Vadö have been lately put is tinning their flesh, which is said to be wholesome, and to find great favour in Catholic countries, where, being fish according to the zoology of the Church, it is allowed to be eaten on fast days.

WE have received the annual report for the past year of Prof. Spencer Baird, Secretary of the Smithsonian Institution. It includes an account of the work performed by the Institution itself, as well as that of the branches of the public service placed by Congress under its charge, namely, the National Museum and the Bureau of Ethnology. A sketch of the work of the United States Fish Commission and of the Geological Survey is added. We observe that the additions to the Museum are described as unexampled in extent, consequent partly upon the labours of the Geological Survey, of the Ethnological Bureau, of the first Commission, and of numerous miscellaneous explorations, both public and private. These various explorations are briefly described. Amongst the forthcoming publications is one on the Botany of North America, by Prof. Asa Gray, part II. of which is in the press. It comprises the Gamopetalous orders from *Caprifoliaceæ* to *Compositæ* inclusive. An enumeration by the author indicates that of the *Caprifoliaceæ* there are 8 genera and 47 species; of *Rubiaceæ*, 26 genera and 86 species; of *Valerianaceæ*, 2 genera and 22 species; of *Dipsacaceæ*, 1 genus and 2 species (naturalised); of *Compositæ*, 237 genera and 1610 species. It will form an octavo volume of nearly 500 pages. The geological map of the United States, commenced in 1883, has been completed and placed in the hands of the engraver. It was found, after collating all available data, that the knowledge acquired is not sufficient to warrant the extension of geological colours over the entire territory of the United States. Accordingly, California, Oregon, and parts of Montana, Idaho, Nevada, Arizona, Utah, New Mexico, and Texas remain

uncoloured. This map will be issued in two editions within a few months. The first edition will be coloured in accordance with the scheme previously adopted and published by the Survey. It will form one of the plates of the Fifth Annual Report of the Survey, and a brief explanatory statement will accompany it. A second edition, with complete explanatory text, will be issued as a bulletin. In this edition the map will be printed in duplicate, one copy coloured in accordance with the published scheme, the other with a scheme now under consideration.

IT is reported from America that Cotopaxi in Ecuador began a serious eruption before daylight on July 23. Streams of lava, with ashes and stones, overwhelmed part of Chimbo, situated near Cotopaxi, and one hundred houses were destroyed. Reports from Guayaquil state that the eruption began at 1 a.m., sounding like incessant discharges of heavy artillery, shaking the earth and rattling windows and doors. At times there was a continuous roar. Guayaquil is 130 miles from Cotopaxi.

ACCORDING to a telegram from St. Petersburg to Scandinavian journals, dated August 4, severe earthquakes have taken place at Tashkend and Wernoje in Russia. In Pishek every house suffered, and the new settlements Sukuluk and Belowodsk were destroyed. In the latter place the church fell in. It is stated that fifty-four persons were killed and sixty injured. The shocks continued to be felt several days, and there are great fissures in the earth.

ACCORDING to a telegram from Simla, shocks of earthquake are again being felt in Cashmere.

THE Anthropological Congress which is shortly to be held at Rome will have a curious feature in a collection of seven hundred skulls of criminals, numbered and classified. To these will be added the photographs of 3000 and the brains of more than 150 convicts, thousands of autographs, poems, sketches, and special instruments, the work of criminals, an album containing a record of 700 observations, physical and moral, on 500 criminals and on 300 ordinary men. There will also be graphic maps of crime in Europe with reference to meteorology, food, institutions, suicide, &c.; tables of the stature of criminals in relation to the length of the arms, and of crime in towns compared to that in the country. M. Bertillon will exhibit the graphic curves of 23,000 *recidivistes* examined in twelve parts of the body and the practical results obtained. Photographs of Russian political and other criminals, especially of those from Moscow, and wax masks of a large number of celebrated criminals, will also be exhibited. All the notabilities in the science of criminal anthropology will take part in the Congress.

THE death is announced from Copenhagen of the eminent Danish archæologist, Prof. Worsaae.

A SUPPLEMENT to the *London Gazette* of August 12 gives a list of Jury Awards to the exhibitors at the International Inventions Exhibition.

THERE are now to be seen at the Inventions Exhibition Aquarium some specimens of the black bass, indigenous to the principal rivers and lakes of Canada and the United States of America, where they are found in abundance. This species is very difficult to rear in the waters of our country, and the manner in which they have become naturalised to their sphere of existence at the aquarium referred to is certainly remarkable. Their introduction to the waters of this country is extremely undesirable on account of their voracity, but they provide excellent sport to the angler.

IN regard to the introduction of the catfish to English waters by the National Fish Culture Association, which is discouraged on account of the voracity of this species, Prof. Baird, the United States Commissioner of Fish and Fisheries, writes to state that the catfish is an unmolesting animal and does not exclusively prefer live food to other kinds. The professor considers much advantage would accrue from their acclimatisation in our waters. The Association referred to has carefully noted their proclivities in the ponds where they are now located and experimented upon their food and at present cannot disprove Prof. Baird's assertion.

PROF. S. NEWCOMB, of Washington, is at present visiting Stockholm, as the guest of Prof. Hugo Gyldén, Astronomer Royal of Sweden. Prof. Newcomb proceeds to Pulkowa in order to visit the Imperial Observatory.

AT about midnight on July 29 a remarkable phenomenon was seen at Jönköping (Sweden), over lake Wettern. A strong luminosity was suddenly seen in the north, where some very peculiar clouds—looking like icebergs—were seen almost to touch the water. From these clouds electrical discharges continually proceeded, imparting to them a bluish, phosphorescent light, somewhat ruddy near the water and intensely yellow at their sides. It seemed like a constant discharge of fireworks from the lake. It was remarkable that the light—as is generally the case with an electrical discharge in the atmosphere—did not assume the form of bunches of streamers, but at one time flared up intensely and at others formed narrow bands across the clouds. Above the latter there was a faint bluish reflection. The lake lay as calm as a mirror, and though an optical illusion was uncommon in these parts, the western shore seemed close to the town, while the eastern disappeared in the clouds. Except the electricity-laden clouds in the north the sky was clear, stars shone, and the full moon was bright. Below the latter the sky seemed faintly red, compared with the intense electric light. At Katrineholm the same phenomenon was seen in the north-east. Here an intense glare was seen above a cloud, assuming the appearance of two gigantic lustrous trees, which remained thus for half an hour, when it changed into a variety of forms. There was no noise accompanying the phenomenon, which lasted in both places for about one hour. It is not probable that the phenomenon could have been of auroral nature on account of the brightness under a full moon.

M. CAMBRELENT, Inspector of Public Works, has made a report to the Agricultural Society of France on the subject of the dunes in the *landes* of Gascony. These sand-hills cover a surface of more than 85,000 hectares; they are more than 80 metres high and 5 to 6 kilometres wide. Before a method of arresting these was discovered they were being constantly pushed inland by the winds, invading and covering fields, villages, and even burying churches up to their towers. In 1780 Brémontier sought to render them immovable by planting them, after many experiments designed to develop a primary vegetation. His work has been continued with perseverance, and it is only recently that it has been completed, and these 85,000 hectares, which menaced all the country adjoining, have become covered with a rich forest vegetation which has fixed the dunes in one place. A great public danger has been converted into a large forest. But this work, which renders permanent, dunes already existing, has not prevented the sea from throwing up on the coast new sand day by day, which forms dunes, which in their turn invade the permanent dunes. After having fixed the old sand-hills, the problem was to prevent the formation of new ones. To solve this it was decided to construct a dune above high water, in which all the conditions of the movable dunes would be reversed. The form given to the latter by the wind is such that on the side of the sea they present a gentle slope, which the sand can mount easily as on an inclined plane, in order to fall down a steep decline. It is by the gentle slopes forming a series of inclined planes that the sand moves forward. The formation of the new dune was encouraged, but it was

directed in such a manner that it had a steep slope on the side of the sea. To secure this a wooden palisade was erected about 120 metres away from the sea, all along the shore. The sand first struck against this in its progress, and fell at its foot, a portion of it escaping through the interstices left between the planks. The latter was carried some distance by the force of the wind, and fell, forming slight slopes, while the sand which fell at the foot of the palisade on the side near the sea formed a steep incline. Soon this reached the top of the palisade, and then the planks were drawn up by means of a special implement to the needed height, and the formation continued as before, the slope on the side of the sea growing steeper, while the other got more and more gentle. Ultimately the dune reaches such a height (generally 10 to 12 metres) that the sand can no longer get over it, and it is definitely arrested between the barrier and the sea. It falls back on the shore, unable to advance, until contrary winds come and blow it out to sea again. To fix the sand on the other side of the barrier, the *Arundo arenaria* is planted. The roots penetrate to a depth of 4 or 5 metres, and the plant always keeps its head above the increasing sand. The results obtained by this new dune (says M. Chambrelent) have been complete. The most violent storms have not been able to carry the sand over it; the latter has fallen back on the shore innocuous, and the advance of the inexhaustible sand coming from the sea has been absolutely arrested.

THE additions to the Zoological Society's Gardens during the past week include a Common Camel (*Camelus dromedarius* ♂) from Egypt, presented by Major Frank Graves; a Shag (*Phalacrocorax graculus*), from Ireland, presented by Capt. F. H. Salvin; a Common Stoat (*Mustela ermina*), British, presented by Mr. H. Hanauer; a Common Chameleon (*Chamæleon vulgaris*), from North Africa, deposited; a Spotted-tailed Dasyure (*Dasyure maculata* ♂), two Yellow-footed Rock Kangaroos (*Petrogale xanthopus* ♂ ♀), from South Australia, received in exchange; a Coquerel's Lemur (*Cheirogaleus coquereli*), an Elliot's Pheasant (*Phasianus ellioti*), a Bar-tailed Pheasant (*Phasianus reevesi*), four Long-fronted Gerbilles (*Gerbillus longifrons*), bred in the Menagerie.

GEOGRAPHICAL NOTES

M. VIOLET D'AOUEST read a note at a late meeting of the Geographical Society of Paris on aërial formations on the soil. Referring to Richthofen's discovery of a vast aërial formation of loess in China, M. d'Aouest described "meteoric formations" which he had himself examined in Mexico. In 1857 he made a communication on this subject to the Society; he found in the flanks of the most elevated mountains argillaceous deposits, which could not be attributed to decomposition of the rocks there, or to the alluvion deposited by rivers, or by the rain. He referred them after investigation to atmospheric currents. In the day the winds raised the particles from the plains and carried them at night to the hills, depositing them there. In course of time these deposits had reached a thickness of thirty to fifty and in places a hundred metres. The upper part, which was generally finer, stopped at the limit of herbaceous vegetation, for beyond this there was nothing to retain the particles, which were carried down by rains, glaciers, snow, or winds to the lower part. Fifteen years later he heard of Richthofen's publication on the subject, and Col. Prjevalsky during his late journeys in Thibet states that analogous aërial deposits are now being formed under the influence of powerful winds which prevail at these altitudes. Subsequently M. d'Aouest met Baron Richthofen and discussed the subject with him, when the latter stated that these formations exist in Europe, adding that it was singular how men, unknown to and far removed from each other, could be led to make the same discoveries in wholly different regions. M. d'Aouest now intends publishing a translation of Richthofen's monograph on the subject, with a supplement of his own containing a number of important documents which he has collected on these deposits. He thinks he will be able to explain loess and argillaceous deposits, the origin of which has hitherto been regarded as problematical, by this theory.

THE *Bollettino* of the Italian Geographical Society for July prints two inedited letters of early Italian adventurers in South America, recently brought to light in the Archives of Florence and Modena. The longer and more important, dated Dec. 24, 1534, is addressed from Valenzuela (Venezuela) by a certain Tomaso Fiaschi to his brother in Florence. After mentioning the preparatory arrangements made for an expedition of 800 men organised for the purpose of seeking gold in the Orinoco basin, the writer—one of the party—describes the country, the appearance and customs of its inhabitants, the nature of the soil, its climate, animal and vegetable productions. The success of the enterprise, which, nevertheless is known to have ended in failure, is anticipated, because the natives "are so bestial and have so little understanding that they think man and horse one and the same thing, and have so much dread of said horses that they die of fear, and one horseman is worth a thousand Indians, and they also greatly dread the blunderbusses, as to them a strange thing it seems to see men dying and not not know from what; so that if they were a hundred and saw four or six of them die, all would take to flight like beasts. And so we shall go to said conquest in the name of God." Further on the men are said to take "one or two wives as best seems to them, and when they don't like them they leave them and take others, and the brother the sister, though true it is mother does not take son, but there are places where they heed nothing and are like the beasts, and worship the sun and moon. And they have a kind of cotton with which they make beautiful things to their fancy, as cloths, which the women wear in front and certain *camach* (hammocks), in which they sleep, which are the length of a man, and are attached to two stakes in their houses. Here no *grano* (wheat?) nor wine is made, but instead of grano they have a certain thing which they call *maize*, which they sow the whole year, and which springs up and grows high in two months; and likewise they sow certain *ceca*, which they call *patatta*, and it has a very large *barba* (root), and said barba is cooked in the ashes, and it has the same taste as the chestnut, &c."

A PROJECT for the compilation of a detailed topography of Italy during the Roman domination will engage the attention of the Italian Historical Congress which meets at Turin next month.

A REUTER telegram from Brussels, dated August 12, says that, according to a message from Madeira in the *Indépendance Belge*, the Marquis Buonfanti, the celebrated explorer, and M. Casman, chief of the Equator station, have died on the Upper Congo.

THE current number (Band xii. Nos. 5 and 6) of the *Verhandlungen der Gesellschaft für Erdkunde zu Berlin* contains a paper by Herr Bandelier on the border lands of ths United States and Mexico, in which he describes the territoriee of New Mexico and Arizona and the Mexican States of Sonora and Chihuahua, their climate, hydrography, topography, flora, fauna, ethnography, antiquities, &c. These subjects are touched rapidly and somewhat superficially, as Herr Bandelier delivered a lecture rather than read a paper. Dr. Hettner referred to his travels in the United States of Columbia. Our geographical knowledge of this region, he said, depends almost wholly on the surveys and description of the Italian Codazzi and the travels of Dr. Reiss and Dr. Stübel, who visited Columbia in 1867 and 1868 with the special purpose of studying the volcanoes. They visited the southern portion, and therefore Dr. Hettner decided, after having investigated the neighbourhood of Bogotá, crossed the Central Cordilleras, and visited the Cauca valley, to direct his journeys to the Eastern Cordilleras, and to study the States of Cundinamarca, Boyacá, and Santander. He had intended originally to include Western Venezuela as far as Carácas in the undertaking, but this had to be ultimately abandoned. The paper gives a brief description of the country and its people, based on these journeys. Dr. Boas describes his journey in Baffin Land in 1883-84. This paper is accompanied by a map showing the outline of the coast of Cumberland Sound and the west coast of Davis Straits according to the English Admiralty charts and to the new survey of Dr. Boas. The discrepancies are very numerous and in some cases very considerable. Herr Wagner contributes a brief sketch of the life and geographical work of the late Prof. Zöppritz.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *AUGUST* 23–29

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on August 23

Sun rises, 5h. 0m.; souths, 12h. 2m. 22·7s.; sets, 19h. 5m.; decl. on meridian, 11° 19′ N.: Sidereal Time at Sunset, 17h. 14m.

Moon (Full on August 25) rises, 17h. 49m.; souths, 22h. 40m.; sets, 3h. 38m.*; decl. on meridian, 13° 55′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 54	13 1	19 8	0 41 N.
Venus	7 46	13 54	20 2	0 50 N.
Mars	0 41	8 56	17 11	23 18 N.
Jupiter	6 8	12 50	19 32	7 41 N.
Saturn	0 8	8 17	16 26	22 26 N.

* Indicates that the setting is that of the following day.

Occultations of Stars by the Moon

August	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
26	67 Aquarii	6	5 9	6 9	151 325
27	B.A.C. 8365	6½	20 48	near approach	162 —

The Occultations of Stars are such as are visible at Greenwich.

August 27 ... h. 11 ... Mercury in conjunction with and 6° 1′ south of Jupiter.

THE MOTOR CENTRES OF THE BRAIN AND THE MECHANISM OF THE WILL[1]

FEELING deeply as I do the responsibility I have incurred in undertaking to address you to-night, I desire to express my regret that I cannot instead share with you the pleasure of listening to the distinguished man who has been prevented by a most painful bereavement from addressing you to-night.

My subject being the mechanism of the will, it might be asked, "What has a surgeon to do with psychology?" To which I would answer, "Everything." For without sheltering myself behind Mr. Jonathan Hutchinson's trite saying that "a surgeon should be a physician who knows how to use his hands," I would remind you that pure science has proved so good a foster-mother to surgery, that diseases of the brain which were formerly considered to be hopeless, are now brought within a measurable distance of the knife, and therefore a step nearer towards cure. Again, I would remind you that surgeons rather than physicians see the experiments which so-called Nature is always providing for us,—experiments which, though horribly clumsy, do on rare occasions, as I shall presently show you to-night, lend us powerful aid in attempting to solve the most obscure problems ever presented to the scientist.

The title I have chosen may possibly be objected to as too comprehensive; but until we are ready to admit a new terminology we must employ the old in order to convey our meaning intelligibly, although there may be coupled therewith the risk of expressing more than we desire. Thus when I speak of the mechanism of the will and the motor centres of the brain, I do not intend (as indeed must be obvious) to discuss the existence of the so-called freedom of the will, or the source of our consciousness of voluntary power.

I shall rather describe to you first the general plan of the mechanism which conveys information to our brain, the thinking organ; next the arrangement of those parts in it which are concerned with voluntary phenomena; and finally I shall seek to show by means of experiment that the consciousness of our existing as single beings, the consciousness of our possessing but one will as people say, while at the same time we know that we possess a double nervous system, is due to the fact that pure volition is dependent entirely on the exercise of the attention which connotes the idea of singleness. Consequently that it is impossible to carry out two totally distinct ideas at one and the same moment of time, when the attention must of course be fully engaged upon each.

[1] Lecture at the Royal Institution of Great Britain by Victor Horsley, F.R.C.S.

I fear that in making my argument consecutive, I shall have to pass over very well-beaten paths, and so I must ask your patience for a few moments while I make good my premisses.

The nervous system, which in man is composed of brain, spinal cord, nerves, and nerve-endings, is arranged upon the simplest plan, although the details of the same become highly complex when we arrive at the top of the brain.

At the same time, while we have this simple plan of structure, we find that there is also a fundamental mode of action of the same—a mode which is a simple exposition of the principle, no effect without a cause—a mode of action which is known as the phenomenon of simple reflex action.

The general plan of the whole nervous system is illustrated by this model. Imbedded in the tissues all over the body, or highly specialised and grouped together in separate organs, such as the eye or ear, we find large numbers of nerve-endings,—that is, small lumps of protoplasm from which a nerve-fibre leads away to the spinal cord and so up to the brain.

These nerve-endings are designed for the reception of the different kinds of vibration by which energy presents itself to us. As the largest example of these nerve-endings, let me here show you one of the so-called Pacinian bodies, or more correctly, Marshall's corpuscles, for Mr. John Marshall discovered these bodies in England before Pacini published his observations in Italy. Here you see one of these small oval bodies arranged on the ends of one of the nerves of the fingers, and here you see the nerve-fibre ending in the little protoplasmic bulb which is protected by a number of concentric sheaths.

Pressure or any form of irritation of this body at the end of the nerve-fibre causes a stream of nerve-energy to travel through the spinal cord to the brain, and so we become conscious that something is happening to the finger.

Here in this section of the sensitive membrane of the back of the eye, the retina, you see a similar arrangement, only more complicated,—namely, nerve-fibres leading away from small protoplasmic masses which possess the property of absorbing light and transforming it into nerve-energy. It is this transformation of nerve-energy into heat, light, pressure, &c., which it seems to me should alone be called a sensation, irrespective of consciousness. And in fact we habitually say we *feel* a sensation. The terms "feeling" and "sensation," however, are frequently used as interchangeable expressions, although, as I shall show you directly, "feeling" is the conscious disturbance of a sensory centre in the surface of the brain, and in fact feeling is the conscious perception of sensations. This distinction between feeling and sensation, if dogmatic, will save us from dispute as to the meaning of the word "sensation"; and further, the distinction is one, as I have just shown, which is justified by custom.

Now the nerve fibre which conveys the energy of the sensation is a round thread of protoplasm which in all probability connects the nerve-ending with a sensory corpuscle in the spinal cord. These nerve-fibres running in nerves are white, whereas, as you know, protoplasm is gray. They are white because each is insulated from its fellow by a white sheath of fatty substance, just as we protect telegraph wires with coatings. It is not stretching analogy too far to say that nerve-force may probably escape unless properly insulated.

In consequence of the fibres being covered with these white sheaths, they form what is called the white matter of the brain; while the nerve centres are grayish, and therefore form what is called the grey matter of the brain, so that the grey matter receives and records the messages conveyed to it by the white insulated fibres.

From the sensory corpuscle, which is a small mass of protoplasm provided with branches connecting it to neighbouring corpuscles, the nerve energy, if adequate, passes along a junction thread of protoplasm to a much larger corpuscle, which is called a motor corpuscle, and the energy of which, when liberated by the nerve impulse from the sensory corpuscle, is capable of exciting muscles into active contraction. These two corpuscles form what is called a nerve centre.

Not only are the motor corpuscles fewer as well as much larger than the sensory ones, but also the nerve fibres which go out from them are larger too. In fact it would seem as if we had another close analogy to electrical phenomena; for here, where we want a sudden discharge of a considerable intensity of nerve force, we find to hand a large accumulator mechanism and a large conductor, the resistance of which may justly be supposed to be low. Finally, the motor nerve-fibre terminates in a protoplasmic mass which is firmly united to a muscle fibre, and which

enables the muscle fibre to contract and so cause movement of one or more muscles. Now, with this idea of the general plan on which the whole nervous system is constructed, you will understand that muscular action, *i.e.* movement, will occur in proportion to (1) the intensity of the stimulation of the sensory corpuscle; and (2) the resistance in the different channels. When a simple flow through the whole apparatus occurs, it is called a simple reflex action, and this was discovered in England by Dr. Marshall Hall.

To recapitulate: a nerve centre, theoretically speaking, we find to consist of a sensory corpuscle on the one hand and a motor corpuscle on the other, both these being united by junction threads or commissures. To such a centre come sensations or impressions from the nerve-endings, and from such a centre go out impulses which set the muscles in action.

I have dwelt thus at length on this most elementary point, because it appears to me that, in consequence of the rapidity with which function is being demonstrated to be definitely localised in various portions of the cerebral hemispheres, we are in danger of losing sight of Dr. Hughlings Jackson's grand generalisations on nerve function, and that we are gradually inclining to the belief that the function of each part is very distinct, and therefore can most readily act without disturbing another part.

In fact, we are perhaps drifting towards the quicksands of spontaneity, and disregarding entirely the facts of every-day life which show that every cycle of nerve action includes a disturbance of the sensory side as well as the active motor agency. Did we in fact admit the possibility of the motor corpuscle acting *per se*, and in the absence of any sensory stimulation we should again be placed in the position of believing that an effect could be produced in the absence of a cause.

For these reasons such a centre has been termed kinæsthetic or sensori motor, and such centres exist in large quantities in the spinal cord, and they perform for us the lower functions of our lives without arousing our consciousness or only the substrata of the same.

But now, turning to the brain, although I am extremely anxious to maintain the idea just enunciated that, when discussing the abstract side of its functions we should remember the sensori motor arrangement of the ideal centre, I shall have to show you directly that the two sides—namely, the sensory and motor—in the brain are separated by a wide interval, and that in consequence we have got into the habit of referring to the groups of sensory and motor corpuscles in the brain as distinct centres. I trust you will not confuse these expressions, this unfortunately feeble terminology, and that you will understand, although parts may be anatomically separated and only connected by commissural threads, that functionally they are closely correlated.

In consequence of the bilateral symmetry of our bodies we possess a double brain—a practically symmetrical arrangement of two intimately connected halves or hemispheres which, as you know, are concerned with opposite sides of the body, for the right hemisphere moves the left limbs, and *vice versâ*.

For my purpose it will be sufficient if we regard the brain as composed of two great collections of gray matter or nerve corpuscles which are connected with sensory nerve-endings, with muscles, and intimately with one another.

In this transverse section of a monkey's brain, which is stained dark blue to show up its component parts, you will see all over the surface a quantity of dark gray matter, which is simply the richly convoluted surface of the brain cut across. Observe it is about a quarter of an inch deep, and from it lead downwards numerous white fibres down towards the spinal cord. The surface of the brain, the highest and most complicated part of the thinking organ, is called the cortex, bark, or rind, and in it are arranged the motor centres I am about to describe. These white fibres coming away from it to the cord, not only are channels conveying messages down to the muscles, but also carrying messages from the innumerable sense corpuscles all over the body.

So much for one grey mass of centres. Now down here at the base of the brain you see two lumps or masses of the same nature, and these are called, therefore, the basal ganglia or grey masses. Since they are placed at the side of the paths from the cortex, and undoubtedly do not interfere with the passage of impulses along those paths, we may put them aside, remembering that they probably are concerned with low actions of the nervous system, such as eating, &c., which are popularly termed automatic functions.

In this photograph of a model made by Prof. Aeby, of Berne, you see represented from the front the two cerebral hemispheres with the centres in the cortex as little masses on the surface, and the basal ganglia as darker ones at the bottom, while leading from them down into the spinal cord are wires to indicate the channels of communication.

Note, in passing, that both hemispheres are connected by a thick band of fibres called the "corpus callosum." It is, I believe, the close union thus produced between the two halves that leads in a great measure (though not wholly) to consonance of ideas.

The arrangement of the fibres will be rendered still clearer by this scheme, in which the cortex is represented by this concave mass, and the fibres issuing from the same by these threads.

The basal ganglia would occupy this position, and they have their own system of fibres.

I will now leave these generalisations, and explain at once the great advance in our knowledge of the brain that has been made during the last decade. The remarkable discovery that the cortex or surface of the brain contained centres which governed definite groups of muscles, was first made by the German observers Hitzig and Fritsch; their results were, however, very incomplete, and it was reserved for Prof. Ferrier to produce a masterly demonstration of the existence and exact position of these centres, and to found an entirely new scheme of cerebral physiology.

The cortex of the brain, although it is convoluted in this exceedingly complex manner, fortunately shows great constancy in the arrangement of its convolutions, and we may therefore readily grasp the main features of the same without much trouble.

From this photograph of the left side of an adult human brain you will see that its outer surface or cortex is deeply fissured by a groove running backward just below its middle, which groove is called the "fissure of Sylvius," after a distinguished mediæval anatomist. This fissure, if carried upwards, would almost divide the brain into a motor half in front and a sensory half behind.

Of equal practical importance is another deep fissure which runs at an open angle to the last, and which is called the "fissure of Rolando," Rolando being another pioneer of cerebral topography. Now it is around this fissure of Rolando that the motor side of the centres for voluntary movement is situated; and when this portion of the cortex is irritated by gentle electric currents, a constant movement follows according to the part stimulated.

Because of their upward direction, the convolutions bounding the fissure of Rolando are called respectively the "ascending frontal" and "ascending parietal" convolutions.

Now here, at the lowest end of the fissure of Rolando, we find motor areas for the movement of both sides of the face: that is to say that, as regards this particular piece of the cortex, it has the power of moving not only its regular side of the face, the right, but also the left—that, in fact, both sides of the face move by impulse from it.

Higher up we find an area for movement of the opposite side of the face only. I reserve for a moment the description of this portion of the brain, and pass on to say that above these centres for the face we find the next is for the upper limb, and most especially the common movement of the upper limb—viz. grasping, indeed the only forward movement which the elbow is capable of, namely, flexion. The grasping and bringing of an object near to us is the commonest movement by far, and we find here that this centre is mainly concerned in it. Behind the fissure of Rolando Dr. Ferrier placed the centres for the fingers.

Next above the arm area is a portion of the cortex which moves the lower limb only, and in front of this again is an area for consonant action of the opposite arm and leg.

Let me here remind you that this being the left hemisphere, these are the centres for movement of the opposite, that is, the right limbs, and that in the other hemisphere there are corresponding areas for the left limbs.

Thus here we have mapped out those portions of the cortex which regulate the voluntary movement of the limbs. So far I have omitted mention of the muscles of the trunk, namely, those which move the shoulders, the hips, and bend and straighten the back. Dr. Ferrier had shown that there existed on the outer surface of the cortex, here, a small area for the movement of the head from side to side.

Prof. Schäfer and myself have found that the large trunk

muscles have special areas for their movement, ranged along the margin of the hemisphere, and dipping over into the longitudinal fissure. Thus all the muscles of the body are now accounted for, and I will first draw special attention to the fact that they are arranged in the order, from below upwards, of face, arm, leg, and trunk.

The consideration of this very definite arrangement led Dr. Lauder Brunton to make the ingenious suggestion that it followed as a necessary result of the progressive evolution of our faculties. For premising, in the first place, from well-ascertained broad generalisations that the highest centre, physically speaking, is also the highest functionally and most recent in acquirement, we find that the lowest is the face, and then we remember that the lowest animals simply grasp their food with their mouth. I imagine it is scarcely necessary for me to repeat the notorious confession that our faculties are arranged for the purpose of obtaining food as the primary object of what is called bare existence.

Proceeding upwards in the scale of evolution we next find animals which can grasp their prey and convey it to the mouth, and so we find next to the face area evolved that for the arm.

And so on, the next step would be the development of the legs to run after the prey, and here is the leg centre; while, finally, the trunk muscles are dragged in to help the limbs more effectually.

To my mind this idea receives overwhelming support from the consideration of the fact that, the higher our centres are the more they require education; the infant, for instance, in a few days shapes its face quite correctly to produce the food-inspiring yell, yet takes months or years to educate its upper limbs to aid it in the same laudable enterprise. Finally, what terrible probation some people pass through at the hands of dancing-masters before their trunk muscles will bend into the bow of politeness.

Now to return to the lower end of the fissure of Rolando, to the areas for movements of the face; it was long ago pointed out by the two Dax's and Prof. Broca that when this portion of the brain immediately in front of the face area was destroyed, that the person lost the power of articulate speech, or was only capable of uttering interjections and customary "strange oaths."

In fact this small portion of the left side of our brains (about $1\frac{1}{2}$ square inches) is the only apparatus for expressing our thoughts by articulating sounds, and note particularly that it is on the left side. The corresponding piece on the right side cannot talk as it were. This remarkable state of things is reversed in left-handed people. In these the right hemisphere predominates; and so we find that when this portion was diseased, there followed aphasia, as it is called. While, however, the right side customarily says nothing, it can be taught to do so in young people, though not in the aged.

Before leaving these motor areas, let me repeat, by way of recapitulation, that the only truly bilaterally acting areas are those for the lower facial and throat muscles. This is a most important fact, for the idea has recently been propounded that both sides of the body are represented in each motor region of each hemisphere. That is to say, each motor area has to do with the movements of both upper limbs, for example. In support of my contention that this is not in accordance with clinical facts, let me here show you photographs of the brain of a man who was unfortunate enough to suffer destruction of the fibres leading from one motor area. Here you see a puncture in the brain which has caused hæmorrhage beneath the fissure of Rolando and the motor convolutions in front and behind it.

In this transverse section of the same spot you see that the hæmorrhage has ploughed up the interior of the brain. Here is the cortical grey matter, but its fibres leading down to the muscles are all destroyed.

Now in examining this patient I asked him to move his left arm or leg; he was perfectly conscious, and, understanding the question, made the effort as we say, but no movement occurred.

Now if both sides of the body are represented in each hemisphere, it seems to me that such a case would be impossible, or at least that a little practice would enable the other hemisphere to do the work; but all clinical facts say that, once destroyed, the loss is never recovered.

If we examine this motor region of the cortex with the microscope we of course find these large corpuscles, which we have learnt are those which alone give energy to the muscles.

But you must not imagine that the motor region consists solely of these corpuscles. On the contrary, as you see in this diagram, we have several layers of corpuscles. I shall return to this arrangement of the corpuscles directly.

Looking back at the surface of the brain you notice that I have only accounted for but a small portion of the cortex. Dr. Ferrier was the first to show that the portion of cortex which perceived (and I use the word in its strictest sense) the sensation of light was this part, and it is therefore called the "visual centre or area." From recent researches it would appear that we must give it the limits drawn on this diagram. Below it we find the centre for hearing.

Thus we know where two sense perceptive centres are situated.

Microscopical investigation shows that this sensorial portion of the cortex is very deficient in large corpuscles, and is correspondingly rich in small cells. Here in this diagram you see these two kinds of structure in the cortex cerebri. Note the greater number and complication of the small corpuscles in the sensory part of the cortex, and the comparatively fewer though much larger corpuscles in the motor region.

It seems to me that several beliefs are justified by these facts.

In the first place the movements produced by the action of these motor centres are always the same for the same centre; consequently it has only one thing to do, one idea as it were. Thus, for instance, bending of the arm: this action can only vary in degree, for the elbow will not permit of other movements. Hence we may look upon it as one idea. Now observe that where one idea is involved, we have but few corpuscles.

Next consider the multitude of ideas that crowd into our mind when we receive a sensation. One idea then rapidly calls up another, and so we find anatomically that there are a corresponding much greater number and complication of nerve-corpuscles.

To sum up, I believe we are justified in asserting that where in the nervous system a considerable intensity of nerve-energy is required—(*e.g.*, for the contraction of muscles)—you find a few large corpuscles and fibres provided, and that where numerous ideas have to be functionalised there numerous small corpuscles are arranged for the purpose.

But now the special interest attaching to the sensory perceptive areas is that they, unlike the motor areas, tend to be related to both sides of the body. With our habit of constantly focussing the two eyes on one object, it will strike you at once that habitually we can only be attentively conscious of one object at a time, since both eyes are engaged in looking at it, and, as you know, we cannot as a matter of fact look at two things at once.

Hence I take it, both sensory perceptive centres are always fully occupied with the same object at the same moment, and that therefore we have complete bilateral representation of both sides of the body in each hemisphere. As a further consequence, each sensory perceptive area will register the idea that engaged it; in other words, both centres will remember the same thing. Thus it happens that each sensory area can perform the duty of the other, and therefore it is a matter of comparative indifference whether one is destroyed or not, and as a matter of fact when this happens we find that the person or animal recognises objects as they actually are, and in fact has no doubt as to their nature. Here you see anatomically the reason of this peculiarity is found to be that the optic or seeing nerves cross one another incompletely in going to each hemisphere, and thus each sensory centre represents half of each eyeball.

I must pass rapidly to the description of the rest of the surface of the brain—the hinder and front ends. At the outset I must admit that all our knowledge concerning them is very hypothetical in the absence of positive experimental results.

This much we can say, that they are probably the seats of intellectual thought, for many reasons which I have not time to detail. Further, we know that these intellectual areas are dependent for their activity entirely on the sensory perceptive centres, for the dictum that there is no consciousness in the absence of sensory stimulation is very well established, as I shall now show you, however astounding it may appear. In the first place, you will remember that when we wish to encourage that natural loss of consciousness which we call sleep, we do all we can to deprive our sense-organs and areas of stimulation; thus we keep ourselves at a constant temperature, we shut off the light, and abolish all noises if we can. But a most valuable observation was made a few years ago by Dr. Strümpell, of Leipzig, who had under his care a youth, the subject of a disease of the brain, &c., which, while destroying the function of one eye and ear, besides the sensibility to touch over the whole body,

still left him when awake quite conscious and able to understand, &c., using his remaining eye and ear for social intercourse. Now when these were carefully closed he became unconscious immediately, in fact slept, and slept until he was aroused again, or awoke naturally as we say after some hours.

Hence the higher functions of the brain exercised when that organ is energising the reasoning of the mind, are absolutely dependent upon the reception of energy from the sense perceptive areas.

But my only point with reference to this part of the brain is to attempt to determine how far they are connected with the motor centres in the performance of a voluntary act. With the mechanism of choice and deliberate action I have nothing to do, but there can be no doubt that the part of the brain concerned in that process of the mind is directly connected with the motor region, as indicated on this diagram, to which I would now return. From what I have here written you read, arranged schematically, the psychical processes which for the sake of argument we may assume are carried on by the mind in these portions of the cortex.

I wish to point out that we have structurally and physiologically demonstrated with great probability the paths and centres of these psychical actions. There is no break: the mere sight of an object causes a stream of energy to travel through our sense areas, expanding as it goes by following the widening sensory paths here represented, and at the same time we feel our intellect learns that new ideas are rising up and finally expand into the process of deliberate thought, concerning which all we know is from that treacherous support, namely introspection.

Then comes impulses to action, and these follow a converse path to the receptive one just described; the nerve energy is concentrated more and more until it culminates in the discharge of the motor corpuscles. We might represent the whole process of the voluntary act by two fans side by side, and the illimitable space above their arcs would serve very well to signify the darkness in which we sit concerning the process of intellectual thought.

What I have hastily sketched is the outline of the process of an attentive or voluntary act. I say attentive advisedly, for I wish now to put forward the view that the proper criterion of the voluntary nature of an act is not the mere effort that is required to perform it, but is the *degree to which the attention is involved*. The popular view of the volitional character of an act being decided by the effort to keep the action sustained is surely incomplete, for in the first place we are not seeking to explain our consciousness of an effort, we endeavour to discover the causation of the effort. Our sense of effort only comes when the will has acted, and that same sense is no doubt largely due to the information which the struggling muscle sends to the brain, and possibly is a conscious appreciation of how much energy this motor corpuscle is giving out.

Now to give you an example. I see this tambour, and decide to squeeze it, and do so. Now this was a distinctly voluntary act; but the volitionary part of it was not the effort made, it was the deliberate decision to cause the movement.

I may now point out that in this whole process we say, and say rightly, that our attention is involved so long as we are deliberating over the object, that as soon as another object is brought to us our attention is distracted, that is to say, turned aside.

All writers are agreed that the attention cannot be divided, that we really only attend to one thing at once.

It seems to me that this is so obvious as not to require experimental demonstration, but I have led up to this point because I now wish to refer to the third part of my subject, namely, the question as to whether we have a really double nervous system or not; but by way of preface let me repeat that although we may have a subconsciousness of objects and acts, that that subconscious state is true automatism, and that such automatic acts are in no sense voluntary until the attention has been concentrated upon them. For example, again I press this tambour because I desire to raise the flag, and I keep that raised while I attend to what I am saying to you. My action of keeping the flag raised is only present to my consciousness in a slight or subordinate degree, and does not require my attention, deliberate thought or choice, and therefore, I repeat, is not a voluntary action, in fact it could be carried on perfectly well by this lower sensori motor centre, which only now and then sends up a message to say it is doing its duty, in the same way as a sentry calls out "All well" at intervals.

But to return. In consequence of the obvious fact that we have two nerve organs, each more or less complete, some writers have imagined that we have two minds; and to the Rev. Mr. Barlow, a former secretary of this Institution, is due the credit of recognising the circumstances which seem to favour that view. It was keenly taken up, and the furore culminated in a German writer (whose name I am ashamed to say has escaped me) postulating that we possess two souls.

Now the evidence upon which this notion rests, that the two halves of the brain might occasionally work independently of one another at the same moment, was of two kinds. In the first place it was asserted that we could do two different things at once, and in the second place evidence was produced of people acting and thinking as if they had two minds.

Now, while of course admitting that habitually one motor centre usually acts at one moment by itself, I am prepared to deny *in toto* that two voluntary acts can be performed at the same time, and I have already shown what is necessary for the fulfilment of all the conditions of volition, and that these conditions are summed up in the word attention.

Further, I have already shown that when an idea comes into the mind owing to some object catching the eye, that both sensory areas are engaged in considering it. It seems to me I might stop here, and say that here was an *à priori* reason why two simultaneous voluntary acts are impossible; but as my statements have met with some opposition, I prefer to demonstrate the fact by some experiments.

The problem, stated in physiological terms, is as follows:—

Can this right motor region act in the process of volition, while at the same time this other motor area is also engaged in a different act of volition?

Some say this is possible; but in all cases quoted I have found that subconscious or automatic actions are confused with truly voluntary acts. I mean that such automatic acts as playing bass and treble are not instances of pure volition, as the attention is not engaged on both notes at once.

Consider for a moment the passage of the nerve impulses through the brain that would have to occur. At the outset we find that the sensory perceptive centres would have to be engaged with two different ideas at once; but Lewes showed long ago that introspection tells us this is impossible, that "consciousness is a seriated change of feelings," he might equally well have said ideas. And again, we know that when two streams of energy of like character meet one another, they mutually arrest each other's progress by reason of interfering with the vibration waves.

I will show directly that this is actually the case in the action of the cortex when the above-mentioned dilemma is presented to it.

The experiment I have devised for this purpose is extremely simple.

A person who is more or less ambidextrous, and who has been accustomed for a long time to draw with both hands, attempts to describe on a flat surface a triangle and circle at the same moment. I chose these figures, after numerous trials, as being the most opposite, seeing that in a triangle there are only three changes of movement, while in a circle the movement is changing direction every moment. To ensure the attempt to draw these figures simultaneously succeeding, it is absolutely necessary that the experimenter should be started by a signal.

When the effort is made there is a very definite sensation in the mind of the conflict that is going on in the cortex of the brain. The idea of the circle alternates with that of the triangle, and the result of this confusion in the intellectual and sensorial portions of the brain is that both motor areas, though remembering, as it were, the determination of the experimenter to draw distinct figures, produce a like confused effect, namely, a circular triangle and a triangular circle. If the drawing is commenced immediately at the sound of the signal it will be found that the triangle predominates; thus, if I determine to draw a triangle with my left hand and a circle with my right, the triangle (though with all its angles rounded off) will be fairly drawn, while the circle will be relatively more altered, of course made triangular. On the other hand, if the two figures are not commenced simultaneously, it will be found that usually the one begun last will appear most distinct in the fused result, in fact will very markedly predominate.

Now the course of events in such an experiment appears to be clear.

The idea of a triangle and circle having been presented to the intellect by the sensory centres, the voluntary effort to

reproduce these is determined upon. Now, if we had a dual mind, and if each hemisphere was capable of acting *per se*, then we should have each intellectual area sending a message to its own motor area, with the result that the two figures would be *distinct* and *correct*, not fused.

The other evidence that I referred to above, which is adduced in favour of the synchronously independent action of the two hemispheres, is from the account of such cases as the following. Prof. Ball, of Paris, records the instance of a young man who one morning heard himself addressed by name, and yet he could not see his interlocutor. He replied, however, and a conversation followed, in the course of which his ghostly visitant informed him that his name was M. Gabbage.

After this occurrence he frequently heard M. Gabbage speaking to him. Unfortunately M. Gabbage was always recommending him to perform very outrageous acts, such as to give an overdose of chlorodyne to a friend's child, and to jump out of a second-floor window. This led to the patient being kept under observation, and it was found that he was suffering from a one-sided hallucination.

Similar cases have been recorded in which disease of one sensory perceptive area has produced unilateral hallucination.

I cannot see that these cases in any way support the notion of the duality of the mind. On the contrary, they go to show that while as a rule the sensory perceptive areas are simultaneously engaged upon one object, it is still possible for one only to be stimulated, and for the mind to conclude that the information it receives in this unusual way must be supernatural, and at any rate proceeding from one side of the body.

To conclude, I have endeavoured to show that as a rule both cerebral hemispheres are engaged at once in the receiving and considering one idea. That under no circumstances can two ideas either be considered or acted upon attentively at the same moment. That therefore the brain is a single instrument.

It now appears to me that one is justified in suggesting that our ideas of our being single individuals is due entirely to this single action of the brain.

Laycock showed that the Ego was the sum of our experience, and every writer since confirms him. But our experience means (1) our perception of ideas transmitted and elaborated by the sensory paths of the brain; and (2) our consciousness of the acts we perform. If now these things are always single, the idea of the Ego surely must also be single.

THE FRENCH ASSOCIATION

THE fourteenth meeting of this Association has been held this year in Grenoble, one of the most intelligent and active French provincial cities, although it has not quite 25,000 inhabitants. It is situated on the banks of the Isère, one of the principal affluents of the Rhone, and is the head city of the Isère department.

The presidential address was delivered by M. Verneuil in the municipal gymnasium in the very hall where girls and boys are daily using horizontal and vertical bars. The actual President, M. Verneuil, is a surgeon in large practice, who delivered a long address on his profession under the title of "Confessions of a Surgeon of the Nineteenth Century." After having tried with much wit and force of expression to dispell prejudices current against practitioners, he went so far as to argue that operations are less frequent in France than in other lands, in spite of animal vivisection being free.

M. Napias, the general secretary, read a long paper on the scientific men who have died during the year, which has been singularly fatal to French science, and he announced the creation of a section of public hygiene and medicine. This section was inaugurated by an address of M. Chauveau, the Director of the Lyons Veterinary School, on the choleraic vaccination by Ferran. Not having been able to witness the operations conducted by Dr. Ferran, the referee was not in a position to give a definite opinion on this all-important matter; but he is satisfied that Dr. Ferran has adhered faithfully to the principles established by M. Pasteur. Although he may be assailed as lacking correct information on the biological part of the question, none of his assumptions can be considered as being in contradiction with well-stated and observed facts. It is probable that his method may be rendered les cumbrous and painful for the patients, but credit must be given to him for his daring experiments.

M. Galande, the treasurer, showed that the Association is possessed now of 20,000*l*., invested in public funds. The amount of the annual subscriptions is 2250*l*., so it leaves a large surplus for the publishing of the transactions and encouragement given to science.

It was announced that the present meeting should have to vote on the fusion with the Association Française, which was created by Leverrier, and presided over by Milne-Edwards since the great astronomer died. No successor will be given to Milne-Edwards, as the two scientific bodies will unite.

The public lectures at the Sorbonne will continue, and a scientific paper will be started, issuing in fortnightly numbers.

M. Rey, the Maire of Grenoble, delivered a complimentary speech to the members of the Association, reminding them that Grenoble was the site of the first Marcel Deprez experiments after their short inauguration at Munich. The results of these important experiments now continuing between Creil and Paris are satisfactory.

In the section of anthropology M. de Mortillet discussed the question of Tertiary man. He said the question was not to know if man as he exists at the present day already existed in the Tertiary epoch. Animals certainly varied from one geological stratum to another, and these variations increased as the strata were geologically distant. The higher the animals the greater the variation. It was to be inferred then that man would vary more rapidly than the other mammals. The problem was not to discover existing man in the Tertiary period, but only to find there an ancestral form of man a predecessor of the man of historical times. The question was, Do there exist in the Tertiary strata objects which imply the existence of an intelligent being? M. de Mortillet has no hesitation in saying there do. These objects have, in fact, been found at two different stages of the Tertiary epoch—in the Lower Tertiary at Thenay, and in the Upper Tertiary, at Otta; in Portugal, and at Puy Courny, in Cantal. These objects proved that at these two epochs there existed in Europe animals acquainted with the use of fire, and able more or less to cut stone. During the Tertiary period there existed, then, animals less intelligent than existing man, but much more intelligent than existing apes. This animal, to which M. de Mortillet gives the name of *anthropithique*, or ape man, was, he maintains, an ancestral form of historic man, whose skeleton has not yet been discovered, but who has made himself known to us in the clearest manner by his works. A number of flints were exhibited from the strata in question, which had been intentionally chipped and exposed to fire. After a long discussion, the almost unanimous opinion was expressed "that after this meeting and discussion at Grenoble there can no longer be a doubt of the existence in the Tertiary period of an ancestral form of man!"

The sitting of the Sections took place in the Palace of the University (Faculties).

NORTH AMERICAN MUSEUMS

A REPORT has just been issued on a visit to the Museums of America and Canada, by V. Ball, M.A., F.R.S., Director of the Science and Art Museum, Dublin. Prof. Ball visited a large number of institutions in various parts of North America, and in his introduction says that he was impressed especially with the system, thoroughness, and good order which appeared to pervade the arrangements in the majority of these institutions. Many of them are of late growth, but already possess an astonishing degree of vigour, while their supporters and officers look forward in a spirit of great hopefulness to what must be described as gigantic extensions of their spheres of usefulness in the future. Largely dependent for their existence on the liberality of private individuals, they take what aid they can get from the Government, and it amounts, in the majority of cases, merely to State recognition. Those of them which possess directly educational functions claim an abundant harvest of good results, and there can be no doubt that the facilities which now exist for instruction in science and art are largely availed of in the principal cities of America.

Mr. Ball did not happen to come across, if such institutions exist, any which were in a condition of decadence from the apathy and indifference of those for whose benefit they had been established. On the contrary, several are unable, owing to their means or room being limited, to receive all the pupils who present themselves.

"That an interest in museums is largely felt in America is not only evidenced by the number of them which are scientifically conducted and the large number of persons who visit them, but it is also proved by the existence of commercially-conducted

museums, which are mere collections of curiosities; these are brought before the public in the true showman style, and there is reason for believing are often very profitable as speculations. The only one of these which I visited is the well-known "Museum" at Niagara Falls, which contains a varied collection of natural history and art objects. In a conversation with its manager, I learnt many amusing particulars as to its history. When I suggested to him getting casts of certain objects, he replied that it would not do for him to exhibit anything but the genuine articles to Americans."

The Smithsonian Institution was of course visited, and Mr. Ball sums up its functions thus:—

"The policy of the Smithsonian Institution is to initiate original plans for abstruse research, especially on lines not occupied by other organisations. It freely gives its publications and specimens without requiring an equivalent in return, and places its books, apparatus, and collections at the disposal of investigators and students in any part of the world. It has been the chief promoter of scientific exploration and investigation of the climate, products, and antiquities of the continent by the United States and State Governments, societies, and individuals."

Of the National Museum, Washington, we are told it is the authorised place of deposit for all objects of natural history, mineralogy, geology, archæology, ethnology, &c., belonging to the United States, or collected by the coast and interior surveys, or by any other parties for the Government of the United States, when no longer needed for investigations in progress.

The contents of the Museum as they now stand have been made up from the following sources:—

"I. The natural history and anthropological collections accumulated since 1850 by the efforts of the officers and correspondents of the Smithsonian Institution.

"II. The collections of the Wilkes' exploring expedition, Perry expedition to Japan, and other naval expeditions.

"III. The collections of the scientific officers of the Pacific Railroad Survey, the Mexican Boundary Survey, and of the surveys carried on by the engineer corps of the Army.

"IV. The collections of the United States Geological Surveys under the direction of the United States geologists, Messrs. Hayden, King, and Powell.

"V. The collections of the United States Fish Commission.

"VI. The gifts by foreign Governments to the Museum or to the President and public officers, who are forbidden to receive them personally.

"VII. The collections made by the United States to illustrate the animal and mineral resources, the fisheries, and the ethnology of the native races of the country on the occasion of the International Exhibition at Philadelphia in 1876, and the fishery collections displayed by the United States in the International Fishery Exhibition at Berlin in 1880.

"VIII. The collections given by the Governments of the several foreign nations, thirty in number, which participated in the Exhibition at Philadelphia.

"IX. The industrial collections given by numerous manufacturing and commercial houses of Europe and America at the time of the Philadelphia Exhibition and subsequently.

"X. The material received in exchange for duplicate specimens from the museums of Europe, Asia, and Australasia, and from numerous institutions in North and South America.

"The United States Geological Survey, under the direction of Major Powell, at present has its offices in the Museum, but they will shortly be removed to spacious quarters which are being provided for them in the city."

Of the Museum, &c., of the Academy of Natural Sciences, Philadelphia, Mr. Ball gives the following interesting account:—

"In a 'Summary History of the Academy,' by Dr. W. S. W. Ruschenberger, dated 1877, we are afforded a full insight into the origin and development of this, which is one of the oldest, if not the premier, society of the kind established in America.

"Its foundation originated in meetings held by a few Philadelphian gentlemen in the years 1811 and 1812. Its opening meeting took place on March 21, 1812, and its objects, as then defined were the pursuit and cultivation of science to the exclusion of everything of a political or sectarian character. It was apparently because of this last declaration that a considerable amount of hostility was excited in religious and other portions of the Philadelphian community. The small band, consisting of fourteen members and thirty-three correspondents, although they were men engaged in business avocations, diligently pursued the aims they had in view in spite of all opposition. Their library and museum steadily augmented, and meetings were held and lectures delivered for the discussion and dissemination of scientific knowledge.

"After various vicissitudes during the troubled years which followed, several removals to more commodious quarters took place, and in 1826 the Academy moved to a building which had been specially prepared for its reception, where two years later it was enabled to throw open its museum, entrance to which, from that time, for forty-two years, or up to 1870, was free to the public for two days in each week. In 1840 the museum and library had again been removed to a building which had been specially constructed for their reception at the cost of several liberal friends of the Academy. Yet again in 1876 a further migration took place to the present building, which is built of brick, faced with green serpentine, as are also many other public buildings in Philadelphia; the style of the architecture is Collegiate Gothic. The museum building and the valuable collections which it contains owe their existence at the present day exclusively to the generous gifts and gratuitous labour of private individuals.

"The functions of the Academy are varied, owing to the different directions in which it operates. Its leading characteristics have been thus summed up: 'It is scientific because it encourages original investigations to the extent of its ability, and publishes whatever investigators may discover for the information of men of science. Its publications are made up entirely of the reported results of original research.

"'It is educational because it gives gratuitous instruction to the beneficiares of the Jessup fund, and opens its library freely to students.

"'It is popular because it seeks to increase the taste for natural science, and spread knowledge by opening its Museum to the public.'"

Recently the byelaws of the Academy have been modified in such a manner as to authorise the establishment of Professorships whenever endowments adequate to their support shall be made. Thirteen proposed Professorships are enumerated, and donations towards an endowment fund are invited which may yield from 1500 to 3000 dollars a year for each year.

"The library consists mainly of works on zoology and botany, but there is also a valuable collection of volumes on Roman, Greek, and French antiquities, and the collections of scientific periodicals of learned societies, which have been largely obtained in exchange for those of the Academy itself, is very rich. In 1876 the library included about 25,000 volumes, since which time it may be presumed that considerable additions have been made.

"Under the direction of the Council of the Academy, the Museum is at present administered by Dr. Leidy, who is assisted by several other Curators. The internal arrangements, owing to overcrowding and the old-fashioned form of the cases, which have not been replaced from want of necessary funds, does not at first sight commend itself as affording any useful hints with reference to the subject of general Museum arrangement; but the contents of many of these cases, as is well known to many men of science, are of great value, as they consist largely of types from which species have been originally described. Here, for instance, are to be found a portion of Gould's famous collection of humming birds, many of Dr. Lea's types of unios, and Dr. Leidy and Prof. Cope's fossil vertebrates. Among these last, most notable is the *Hadrosaurus*, an ideal restoration of which rears its lofty frame in a prominent position in the main gallery. More is now known as to the characteristics of those kangaroo-like reptiles (*Deinosaurs*) than was the case when Dr. Leidy named this one after its discoverer, Mr. Foulke. The ornithological collection, which is one of the largest in the world, contains, in addition to the humming-birds already mentioned, numerous rare specimens, one of them being the now extinct Great Awk, of which there is another example in the New York Museum of Natural History. The collection of shells which is under the custody of Mr. Tyron is renowned for its extent and value.

"The Herbarium is considered by good authorities to be one of the richest, if not the richest, in the United States. In 1876 it contained upwards of 46,000 species of plants. It was commenced in 1812, since which time it has absorbed many private collections, either given or bequeathed to it by their owners or purchased out of funds provided by friends of the Academy. Besides a general collection of minerals there is a special one which was bequeathed by the late Mr. Vaux, who also left a sum of money to provide an endowment fund for the payment

of the salary of a curator and for the acquisition of new specimens. This collection, so liberally provided for, includes many noble examples of rare minerals.

"The University of Pennsylvania possesses also a mineral cabinet which is administered by Dr. Genth, whose private collection is probably in some respects unique, especially as regards pseudomorphs and minerals which have been derived from others by alteration. Here it may be mentioned that in Philadelphia there are several important private collections of minerals which have been acquired at great expense by their owners—among them those of Dr. Lea and Mr. Bemment are especially noteworthy. However scientific institutions may have progressed in other parts of the United States of late years, Americans cannot but admit the debt which their country owes to the Academy of Natural Sciences for the leading part which it has taken for so many years in the advancement of knowledge of the natural sciences."

Mr. Ball gives a somewhat detailed account of the American Museum of Natural History, New York, which, however, we need not quote, as we recently referred to it in some detail.

The well-known Massachusetts Institute of Technology, Boston, was founded by charter in 1841, its objects, as sketched out by its first President, Prof. Rogers, being threefold, namely, the establishment of a Society of Arts, a Museum of Arts, and a School of Industrial Science. The Society of Arts was the first part of the scheme to be organised. It holds fortnightly meetings, from October to May, the objects of which are to "awaken and maintain an active interest in the practical sciences, and to aid generally in their advancement and development in connection with arts, agriculture, manufactures, and commerce." Discoveries and inventions are described and discussed at these meetings. Judging from the titles and characters of the subjects which have been communicated, the results of these meetings are often doubtless of such a character as to confer great benefit on the community at large. Abstracts of the proceedings are published in the annual reports.

In the new building a spacious and suitable hall has been provided for an Industrial Museum; but, although varied and valuable collections have been made of material suitable for such a Museum, it has been necessary to make use of them in the different departments of the school, where they are placed so as to be easy of access to teachers and students, which would not be the case were they centralised in the main building. The most important branch of the institution, Mr. Ball states, which has excited the admiration of so many visitors, is the School of Industrial Science.

This school was founded in 1865, and two subsidiary schools have since been organised under the control of the Corporation of the Institute. These are, respectively, the Lowell School of Practical Design and the School of Mechanic Arts. The studies in the school "are so arranged as to offer a practical and liberal education in preparation for active pursuits, as well as a thorough training for most of the active professions."

The regular courses, each of four years' duration, are as follows:—

- I. Civil and topographical engineering.
- II. Mechanical engineering.
- III. A. Mining engineering.
- III. B. Geology and mining.
- IV. Architecture.
- V. A.B.C. Chemistry.
- VI. Metallurgy.
- VII. A. Natural history.
- VII. B. Preparatory to the professional study of medicine.
- VIII. A. Physics.
- VIII. B. Electrical engineering.
- IX. A.B.C. General courses.

For proficiency in any one of these courses the degree of Bachelor in Science (S.B.), in the course pursued, is conferred.

The first six of these courses and VIII. B. are distinctly professional. The general courses IX. A.B.C. are for students who, though not desiring to enter a distinctly scientific profession, desire an education of a pre-eminently scientific character. Advanced courses of study may be pursued with or without reference to the higher degree of Doctor of Science. Women who are properly qualified are admitted to any of the courses of the school, and special laboratories in the different branches of study have been provided for their use. Schedules of prescribed studies in the various courses indicate very clearly the weight which is given to the modern languages and other branches of a liberal but strictly non-classical education.

The staff of professors and assistants is a large and highly competent one, and the practical part of the instruction appears to be carried on in a very earnest and sound manner. The fee for regular students is 400 dollars per annum, to which in estimating the total cost must be added board and lodging in the town, books, instruments, and personal expenditure. There are at present about 440 students on the roll. From the records of the School it would appear that numbers of its graduates occupy important positions all over the country, for which their special training has qualified them.

The School of Mechanic Arts is for the benefit of those who, from want of time or means, are unable to go through one of the regular courses of the School of Industrial Science. "The object is to develope the bodily and mental powers in harmony with each other." Its exact and systematic method affords the direct advantage of training the hand and the eye for accurate and efficient service with the greatest economy of time. The instruction in the mechanic arts given to each regular student at present embraces:—I. Carpentry and joinery; II. Wood turning; III. Pattern making; IV. Foundry work; V. Iron forging; VI. Vice work; VII. Machine tool work. The regular course includes two years of study in English, French, and elementary mathematics and physics. The general plan of the School is founded upon the systems followed in the Imperial Technical School of Moscow, the Royal Mechanical Art School of Komotan in Bohemia, the École Municipale d'Apprentis of Paris, and the Ambachts Schoole of the principal cities of Holland, modified, however, to suit local conditions. Applicants for entrance must be at least fifteen years old, and must pass an examination in arithmetic, geography, and composition. Fifty-six students have been on the roll during the current year.

The Lowell School of Practical Design was established by the trustees of the Lowell Institute for the purpose of promoting industrial art in the United States, but it is under the administration of the Corporation of the Institute of Technology. Tuition is free to all pupils. A considerable degree of skill in freehand drawing from nature and in the use of the brush is positively required for entrance to the school, which does not undertake to teach drawing

"*Course of Study*.—Students are taught the art of making patterns for prints, ginghams, delaines, silks, laces, paperhangings, carpets, oil-cloths, &c. The course is of three years' duration, and embraces (1) technical manipulations; (2) copying and variations of designs; (3) original designs or composition of patterns; (4) the making of working drawings and finishing of designs."

The school is provided with looms for different fabrics, and the pupils have the opportunity of working their designs in various materials. A constant supply of samples of novelties in textile fabrics of all kinds is received from Paris. Those students who, at the close of the half year, do not show evidence of progress are permitted to withdraw. Some sixty students have received certificates from this school, and the majority of them have found employment in various factories and other places of business.

Among other institutions referred to in this Report are the Harvard Museum of Comparative Zoology, the Meteorological Museum, Harvard, the Peabody Museum, Connecticut, the Peter Redpath Museum, Montreal, and the Geological Museum, Ottawa. The Report is illustrated by numerous views and plans.

SCIENTIFIC SERIALS

Königliche Gesellschaft der Wissenschaften, Göttingen, January to March, 1885.—Memoir on Jacob Grimm, by F. Frensdorff.—On the optical properties of very thin metal plates, by W. Voigt.—Seventh annual report on the treatment of ear complaints in University Hospital, Göttingen, by Dr. K. Bürkner.—A contribution to the history of the Papacy during the tenth century, by Ludwig Weiland.—On the electric conductivity of liquid solutions in a state of extreme dilution, by Friedrich Kohlrausch.—On the Eris of Greek mythology, her outward appearance and representation in plastic art and literature, by Friedrich Wieseler.—On the theory of complex magnitudes formed of *n* units, by R. Dedekind.—The organic Aryan inflection of the locative case singular of the *u* declension, by A. Bezzenberger.—On Euler's integral in connection with Cauchy's "Mémoire sur les Intégrales définies," by A. Enneper.—A demonstration of the multiplication theorem for the determinants, by M. Falk.—A

contribution to the study of the sympathetic nerves in the higher mammals, by Fr. Huth.—On some definite integrals by A. Enneper.—On the maximum of a four-sided figure of given dimensions, by A. Enneper.

Rendiconti del Reale Istituto Lombardo, July 9.—Principles of criminal law; preventive measures and police offences, concluded, by Dr. Raffaele Nulli.—The conflict between Julius Cæsar and the Senate, continued, by Prof. J. Gentile.—Direct oxidation of the iodides and of ammoniacal and organic nitrogen, especially by means of the bioxides of lead and manganese, by Prof. E. Pollacci.—Effects of the phosphates and other fertilisers on the wheat crops, by Prof. Gaetano Cantoni.—An exposition of Riemann's memoir on the theory of the Abelian functions, by Prof. Giulio Assoli.

SOCIETIES AND ACADEMIES

EDINBURGH

Royal Society, July 20.—Mr. David Milne-Home, LL.D., Vice-President, in the chair.—Dr. Harvey Gibson read the second part of his paper on *Patella*.—Prof. Tait read a paper by the Rev. T. P. Kirkman on the unifilar knots with ten crossings; and also a paper of his own on the census of ten-fold knottiness. There are 364 different forms of ten-fold knottiness, when the crossings are alternately over and under, included in 124 types, 50 of which are unique, while 74 have multiple forms.—Prof. Tait also communicated a paper by Messrs. Crocket and Creelman on the thermal effects produced in solids and in liquids by sudden large changes of pressure, and a paper by Mr. W. Peddie on a method of determining the resistance of electrolytes without endeavouring to prevent polarisation.—Prof. MacFadyean and Dr. G. S. Woodhead submitted an account of the construction of the auricles of the pig's heart. Beating of the heart and the superior *vena cava* may continue under proper stimulation for a few hours after death.—Mr. A. P. Laurie communicated a note of the heat of solution of zinc iodide. The heat of solution was determined by observations of the electromotive force of a voltaic cell invented by himself for the purpose.—Dr. J. McFarlane read a second paper on pitchered insectivorous plants.—Mr. H. R. Mill, of the Scottish Marine Station, read a paper on the salinity of the Tay estuary and of St. Andrew's Bay.—The meeting, which was the last for the session, was concluded by an address from the chairman.

PARIS

Academy of Sciences, August 10.—M. Bouley, President, in the chair.—Note on the chief momenta of terrestrial inertia, by M. F. Tisserand.—Remarks on the third part of the Map of Tunis, published by the French War Office, and presented to the Academy by Col. Perrier. The map is to the scale of 1 : 200,000, and the present sheets comprise the districts of Gafsa, Maharès, Kebili, Gabès (Cabes), and Zarzis. Three sheets only remain to complete the whole work, and for these the surveys have already been made.—The sixth part of the General Map of Africa, executed for the War Office to the scale of 1 : 2,000,000 by Capt. de Launoy. This part contains eight sheets comprising the districts of Tabora, Zanzibar, Livingstonia, Vicloux, Mossamedes, Linyanti, Tete, Quilimané.—Note on a registrar of the calorific intensity of solar radiation (one illustration), by M. A. Crova. The apparatus here described is intended faithfully to record the readings of an actinometer giving the calorific intensity of solar radiation to which it is *directly* exposed, while protected from the disturbing action of the winds.—On the treatment of mildew (*Peronospora vitis*) by means of sulphurous acid, by M. Emile Vidal.—A certificate, prepared by Dr. Ferran and signed by several physicians, respecting the results of anti-choleraic inoculations at Benifayo, accompanied by a diagram showing the progress of the epidemic before and after these inoculations, was presented to the Academy, by M. F. Angla. Similar documents are promised for other districts. A telegram was also received from M. Paul Gibier regarding the experiments made by him with hypodermic inoculations of the cholera bacillus.—Observation on Tuttle's comet, the return of which was noticed on August 8 and 9 by M. Perrotin at the Observatory of Nice.—Remarks on a demonstration of the law of reciprocity in mathematical analysis, by M. A. Genocchi.—On the temperatures and critical point of pressure for the chloride of ethyl, and another series of homologous bodies comprising ammonia, gas, and the three methylamines, by MM. C. Vincent and J. Chappuis.—On aqueous evaporation in a disturbed state of the atmosphere, by M. Houdaille.—On a method of obtaining a true standard volt; cause of previous errors, by M. A. Gaiffe.—Products of the oxidation of carbon by the electrolysis of an ammoniacal solution, by M. A. Millot.—On certain alloys of cobalt and copper, by M. G. Guillemin. The alloy with 5 per cent. of cobalt is described as specially interesting, being capable of resisting oxidation, malleable as ordinary copper, tenacious and ductile as iron. It might be largely used in the manufacture of rivets, tubes, and a great variety of copper-ware articles in daily use.—On the thermic phenomena attending the transformation of the protochloride of chromium into a sesqui-chloride, by M. Recoura.—On the crystallographic characters of the substituted derivatives of camphor, by MM. P. Cazeneuve and J. Morel.—On a new species of land turtle (*Testudo yniphora*) brought by M. Humblot from the Comoro Islands, and presented by him to the Natural History Museum of Paris, by M. Léon Vaillant.—On the Brisingidæ fished up from great depths by the *Talisman* Expedition, by M. Edmond Perrier.—Position of the embryo and formation of the cocoon in *Periplaneta orientalis*. The author describes the results of his observations, continued throughout the whole formation and evolution of the egg of this insect for the purpose of determining the exact relations existing between the organic axis of the egg, the principal axis of the embryo, and that of the maternal organism.—On the local treatment of fibrinous pneumonia by means of intra-parenchymatose injections, by M. R. Lépine.—On the cystitis and nephritis produced in the healthy animal organism by the introduction of the micrococcus ureæ (Cohn) into the urethra, by MM. R. Lépine and Gabriel Roux.—Note on the microbe of typhoid fever in man, its cultivation and inoculation, by M. Tayon.—Transmission of pathogenetic microbes from mother to fœtus, by M. Koubassoff.—An explanation of the abnormal development of the grape occasionally occurring in the vineyards of the Vaudois district, by M. J. B. Schnetzler.—On a specimen of pine found embedded in the upper Tschingel glacier at an altitude of 2475 metres, far above the present zone of the pine in this region, by M. Paul Charpentier.—Note on the employment of atmospheric heat for the purpose of obtaining a motor power capable of raising water to a certain height, by M. Ch. Tellier.

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